

Exploring the Effects of AI-Assisted Learning on CSL Students' Executive Functions and Writing Skills: Yanshan University as an Example

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Abstract: This paper mainly discusses the influence of AI-assisted learning on CSL college students' writing and executive function. It is found that AI-assisted learning can help students improve their Chinese writing performance and affect their executive functions. EFs is important to students writing process, students can better complete writing tasks and obtain higher scores under executive functions.

Keywords: AI-Assisted Learning; Chinese as a Second Language; Writing; Executive Functions

1. Introduction

Chinese writing is an important element in assessing the language proficiency of L2 learners in teaching Chinese as a second language (TCSL). In the field of second language learning, artificial intelligence (AI) has become a popular tool to support students overcoming writing difficulties by providing with instant feedback and correctly coherent sentences.

With the introduction of process-oriented model of writing, there has been an increasing amount of research focusing on the process of second language writing and related behaviours. Kellogg's (1996) writing model is one of the most influential models and it is based on the focus on the writing process and cognitive encoding, distinguishes three major processes of writing. Executive Functions (EFs) has long been viewed as a key function that influences students' writing processes. It can be defined as a set of cognitive systems that guide people to complete learning activities consciously. Many studies have corroborated the positive effects of EFs on writing performance. Nevertheless, relatively few studies in the field of CSL have explored the relationship between AI on students' EF and writing.

This study will use Kellogg's writing model as a theoretical foundation to investigate the students' writing process and explore the impact of AI-assisted learning on CSL university students' writing skills and executive functions. It will also delve into the relationship between students' EF and writing skills under AI-assisted learning.

2. Literature Review

In the field of teaching Chinese as a second language, studies on AI-assisted second language writing have shown its positive impacts. Li et al. (2023) investigated the potential of GPT in improving the writing of second language Chinese learners using four 9th grade native English speaking students. The study found that using ChatGPT could help correct errors and refine sentence structure in writing, thus helping Chinese learners improve their Chinese writing performance. Huang and Lam (2023) investigated the effectiveness of integrating the Seesaw platform into process-oriented second-language Chinese writing. The study was conducted with 24 primary school students from an international school over five weeks. The results showed that integrating information technology into the Chinese writing process can help provide writers with more information resources and relevant sentence patterns, and improve students' motivation, effectiveness, and writing ability in Chinese writing.

Executive Functions are critical to students' self-directed behaviors and some research has evaluated the effects of EFs on students' writing. Executive Functions can be distinguished with four different components: Inhibition (i.e., suppressing irrelevant information), working memory (i.e., storing and updating information), shifting (i.e., shifting between perspectives or attention), and planning (i.e., Choosing the right steps to achieve the goal (Liao, 2024). Altemeier et al. (2006) found that EFs contribute to the

development of writing in elementary school students by examining the reports of 251 Seattle elementary school students tested on two reading and writing tasks. The results supported the hypothesis that EFs played a connection role in reading and writing. Cordeiro et al. (2020) examined the writing texts of 116 native Portuguese-speaking second graders during different periods. They also concluded that EFs significantly contributed to the quality of elementary school students' written texts. In China, Liao and Zhao (2024) examined 135 first-year Hong Kong undergraduates by examining the integrated listening-reading Chinese writing task and a five-item EF task test. The study revealed that undergraduates' EFs, especially inhibition, visual-spatial working memory, and planning skills, could directly predict their writing performance, and the visual-spatial working memory could indirectly affect writing performance through integration activities.

In summary, studies have begun to focus on the effects of EFs on writing, but they have centred more on ESL writing than CSL writing. So this study will investigate how AI-assisted learning can be integrated into L2 Chinese writing instruction to affect CSL university students' EFs and writing skills.

3. The Experiment

3.1 Theoretical Framework

This study draws on Kellogg's (1996) model of writing processes as the theoretical framework. It distinguishes three major processes in writing: Formulation, Execution and Monitoring, these processes can be done simultaneously. Kellogg's writing model provides an important resource for research in the second language writing based on a focus on writing processes and cognitive encoding, which make it possible for this study to focus on the writing process.

3.2 Experimental Participants

The participants of this study will be

international students from Yanshan University. The Chinese language proficiency of the target students is at the level of HSK 4 or above. The number of students in the experimental group is 22, including 10 males and 12 females. The mean age of this group is 19.7. The number of students in the control group is 23, with 12 males and 11 females. Their mean age is 19.56. The instructor will be an experienced teacher who is currently an associate professor with eight years of teaching experience. Before conducting this experimental study, the study will train this teacher to use AI-assisted writing instruction.

For ethical considerations, all participants in this study will be informed of the purpose of this study and sign a written consent for participation. In addition, their personal information will be kept strictly confidential and they have the right to withdraw from this study at any time without any penalty.

3.3 Experimental Design

This study will use a quasi-experimental approach. It will conduct an experimental study with two college classes, with one class serving as an experimental class using AI-assisted teaching methods, while the other class serving as a control class and following traditional teaching methods.

Specifically, This study will conduct a 12-week experiment, with once per week and each class lasting 2 hours. The entire writing teaching process is designed based on Kellogg's writing model, with formulation execution and monitoring as the pre-writing, writing and post-writing phases. Both classes will follow these three phases of writing instruction, where each phase of the experimental class will be supplemented with AI-assisted learning methods, and the control class will be taught using traditional methods. This study will illustrate the experimental process by using the topic "Talk about your knowledge of 'To do his work well, must first sharpen his tools' and argue your point of view" as an example (see Table 1).

Table 1. Diagram of the Teaching Process

Teaching process		experimental class	control class
teaching stage	timing	12 weeks	12 weeks
Pre-teaching stage of writing instruction: explaining the	Week 1	Teacher introduces the meaning of "To do his work well, must first sharpen his tools" and assigns the writing task. At the same time, students can consult ChatGPT to help them better understand the topic.	The teacher introduces the meaning of "To do his work well, must first sharpen his tools" and assigns the writing task.

topic to students and gathering information	Week 2	Students discuss in groups, and record relevant ideas. Students can sort out words and sentences with the help of ChatGPT.	Students discuss in groups, recording relevant ideas. Students can only combine words and phrases with the help of the teacher.
The middle stage of writing instruction: the teacher teaches the ideas and structure of argumentative writing and students write essays	Week 3	The teacher teaches how to write the opening paragraph of an argumentative essay, students write this section and can use ChatGPT to help with the writing.	Teacher teaches how to write the first paragraph of an argumentative essay and the students write this part. This section can only be done with the tutelage of the teacher, no intelligent tools are allowed.
	Week 4	Students share their work in class and receive information provided by ChatGPT on wrongly written or mispronounced characters, Grammar, organization, coherence, sentence structure feedback and revise the text according to the suggestions.	Students share their work in class, receive evaluation and feedback only from the teacher and peers, and revise the text based on suggestions.
	Weeks 5-8	The teacher teaches students how to write the main body section of an argumentative essay, including the expression of ideas, the use of thesis arguments. Students use ChatGPT to further understand the section and write the main body of the essay. Similarly, for the feedback on the main part of the essay, students have the opportunity to make corrections with the help of ChatGPT on wrongly written or mispronounced characters, Grammar, vocabulary, organization, coherence, and sentence structure.	The teacher teaches students how to write the main part of an argumentative essay, including the expression of ideas, the use of thesis arguments, and the articulation of statements. Students write the main part of an essay chapter. The control class will only accept face-to-face feedback provided by the instructor and classmates during the essay feedback phase; no ChatGPT feedback will be accepted.
	Weeks 9-10	The teacher teaches how to write an argumentative closing paragraph, and students can consult ChatGPT to further their learning and write an argumentative closing paragraph. Students receive multiple feedback suggestions from the teacher, peers, and ChatGPT and revise their texts.	The teacher teaches how to write an argumentative closing paragraph and students write an argumentative closing paragraph. Students only receive feedback from the teacher and peers to revise the text.
Post-teaching stage of writing: further revision	Weeks 11-12	Students check the full text and share it in the class with the teacher and classmates commenting on it. Further revision can be done with the help of ChatGPT.	Students check the full text and share it in the class, with the teacher and classmates critiquing it and making their own revisions in class.

4. Data

4.1 Data collection

Data collection for this study will include EF questionnaire and students' writing tests. The specific data collection process is shown in Table 2.

(1) EF questionnaire

This study will use an EF questionnaire to understand and compare the changes in students'

EFs before and after teaching. The survey involves four dimensions: Response Inhibition, Working Memory, Cognitive Flexibility and planning. Some sample questions are shown in Table 3.

Table 2. Data Collection Process

Stage I: Pre-test, EF questionnaire
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Stage II: Teaching Experiment and Collect Texts for Writing Revision During Instruction
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Stage III: Post-test, EF questionnaire

Table 3. Examples of EF Questionnaire

Dimensions	definition	Sample question
Inhibition	The capacity to think before you act.	I don't jump to conclusions.
Working Memory	The ability to hold information in memory while performing complex tasks.	I have a good memory of facts, dates, and details.
Shifting	The faculty to shifting between perspectives or attention	I find it easy to stay focused on my work.
Planning	Choosing the right steps to achieve the goal	I can easily focus on the most important things .

(2) Writing skills tests

Following the completion of the 12-week intervention period, all participants, both in the control and experimental groups, will receive the same writing questions before and after the experiment. The test topic is about argumentative writing, which is a type of academic writing and one of the mandatory genres in the Chinese Proficiency Test (HSK). In addition, writing texts practised by students during the teaching will be collected for reference.

4.2 Data Analysis

SPSS will be used to analyze questionnaire data. Specifically, descriptive analysis will be done to count the data of the questionnaire and test such as total score, mean score, and variance, to know the overall EFs and writing skills of the students. Then, this study will use T-test to compare the results of the pre-test and post-test of students' EFs and academic writing and those between the two groups to reveal the impact of AI-assisted teaching on students. In addition, correlation analysis will be used to show the relationship between students' EFs and writing skills.

5. Conclusion

Based on Kellogg's (1996) model of writing processes, the main purpose of this study is to investigate the effects of AI-assisted instruction on the writing performance and EFs of CSL university students. The experimental results showed that the AI-assisted class is superior in terms of writing scores and the performance of executive functions, which most likely due to the interactive and timely feedback environment created by the AI. In an AI-assisted environment, components of executive functions will be activated to a greater extent, which is particularly important for writing, and different components may have different effects on second language writing.

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