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Exploring the Young Learners' Interactions with AI-generated Multimodal Feedback in Collaborative Writing

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Abstract: The rapid transformation of education by artificial intelligence (AI) has emerged as a pivotal solution to language learning. Recently, AI-enabled automated feedback learning systems signify a growing effort to support the teaching and learning in Chinese language. However, it can be found that recent scholars have primarily focused on the utilization of automated feedback for individual self-regulated learning and the application of unimodal feedback to augment students' learning outcomes. There is limited research on how AI-generated multimodal feedback can promote meaningful learning process and engaging students within collaborative language learning environments. Consequently, this research proposes employing a mixed methods approach to investigate how AI-generated multimodal feedback (comprising AI-generated image feedback, AI-enabled audio feedback, and automatic scoring) can promote vocabulary learning for young learners in collaborative Chinese language learning activities. This investigation will focus not only on students' learning outcomes but also on the learning process and learner enjoyment, as a way to explore the multiple dimensions of feedback in learning. This research seeks to gain insights into effective pedagogical strategies and their implications for AI-generated multimodal feedback in collaborative language learning.

Keywords: Artificial intelligence, multimodal feedback, second language writing, young learners

1. Introduction

The significance of feedback in the field of education has been widely acknowledged. However, due to the often-substantial disparity between teachers and students in real classrooms, educators frequently grapple with the challenge of providing timely, high-quality, and personalized feedback – an essential component for facilitating meaningful learning (Howard, 2020).

The rapid transformation of education by artificial intelligence (AI) has emerged as a pivotal solution to address existing gaps in teaching and learning. AI-enabled automated feedback systems represent a significant advancement in supporting language education (Godwin-Jones, 2022; Demszky et al., 2023) and are widely applied in the field of automated writing evaluation (Stevenson & Phakiti, 2014). Existing research on AI-enabled automated feedback for language learning has primarily focused on whether such feedback contributes to academic achievement in writing (Miranty & Widiati, 2021) or on assessing the effects of different types of written corrective feedback on learning outcomes (Taşkıran & Göksel, 2022). However, there is a notable lack of research on the integration of AI-enabled feedback in promoting the learning process within the context of collaborative learning (Liang et al., 2021). Moreover, studies need to further explore learners' social interactions within AI-enabled feedback environments, moving beyond simply examining students' satisfaction with AI as a learning technology (Demszky et al., 2023).

In light of these considerations, this research proposes a mixed methods approach to investigate how self-designed AI-generated multimodal feedback can promote Chinese language learning among young learners in collaborative vocabulary learning activities. This study will not only focus on students' learning outcomes but will also explore their interactions

during the collaborative learning process, aims to understand how AI-generated multimodal feedback engages young learners in Chinese as second language (L2) writing, as well as to assess its impacts and potential in enriching the language learning experience. Additionally, the study will explore effective pedagogical strategies and consider their implications for the use of AI-generated multimodal feedback in future collaborative language learning.

2. Literature Review

2.1 AI-generated Multimodal Feedback in L2 writing.

With the advancement of AI algorithms, a growing body of research has focused on pioneering forms of automatic indirect feedback that encompass audio, visual, spatial, and tactile modes for sentence construction and writing. These modes actively engage learners by encouraging experimentation, exploration, and discovery (Campbell & Feldmann, 2017). This trend has given rise to the concept of "multimodal feedback" (Moreno & Mayer, 2007). The recent rise of generative AI language models over the past three years has expanded the possibilities for enhancing the learning context in language education. Studies have demonstrated the effectiveness of using image-to-text generative AI to promote vocabulary acquisition and significantly improve students' learning performance (Shadiev et al., 2020; Hsu et al., 2023).

In my study, AI-generated image feedback, AI-enabled audio feedback, and automatic scoring will be integrated into the designed multimodal feedback system, tailored specifically to accommodate the learning characteristics of young beginners (see Table 1). This approach aims to effectively promote young learners' engagement in L2 collaborative writing activities through an indirect and vivid feedback mechanism.

Table 1, *the design of AI-generated multimodal feedback*

AI-enabled audio feedback	Automatic scoring	AI-generated image feedback
The system offers a sample image that students can use as a basis for their descriptions. Students compose a sentence in response and subsequently submit it. Correspondingly, the system delivers AI-powered audio feedback, enabling group members to evaluate accuracy by listening to the pronunciation and comments.	Meanwhile, the system will automatically assess group artifacts and display a star rating ranging from 1 to 4, allowing students to self-assess their learning achievements.	Furthermore, the system automatically generates an image using the submitted artifact. In comparison to the sample image, students can make additional enhancements to their artifacts and submit them again.

2.2 A multidimensional framework of L2 writing feedback and its impact.

The conceptualization of feedback has increasingly shifted towards a more learner-centered perspective over the past two decades. Recent studies (Henderson et al., 2019; Liu & Yu, 2022) adopt a more comprehensive approach to defining L2 writing feedback and its impact, viewing it as a multidimensional construct comprising feedback as information, cognition (internal process), and sociocultural interaction. In this sense, L2 writing feedback is not merely a scaffold for students in acquiring writing skills in a foreign language, it is a complex interplay of textual, cognitive, and sociocultural mediations that is central to the development of their educational identities, such as L2 writers, language learners, and active learners (Carless, 2020; Boud & Molloy, 2013). According to Liu and Yu's systematic review (2022), L2 writing feedback can influence students' written outcomes from an information-based perspective, impact the writing process from a cognitive learning perspective, and shape how students position themselves within the feedback process through sociocultural interaction. Based on this framework, I will firstly focus on students' writing artifacts and the academic achievements prompted by AI-generated multimodal feedback from an information-based perspective. Second, I will examine group behaviors and cognition during learning activities to investigate the impact of AI-generated multimodal feedback on the internal writing process. Third, I will analyze students' enjoyment of interacting with learning activities to explore the impact of AI-generated multimodal feedback as a form of social interaction. The proposed research questions are as follows:

1. **Does** AI-generated multimodal feedback promote students' writing in collaborative Chinese language learning?
    1.1 Does AI-generated multimodal feedback promote students' academic performance in Chinese language learning?
    1.2 Does AI-generated multimodal feedback promote students' learning artifacts in collaborative Chinese language learning?
    1.3 Does the use of AI-generated multimodal feedback affect the quality of group artifacts?
    1.4 Does AI-generated multimodal feedback promote students' enjoyment in collaborative Chinese language learning?
2. **How** does AI-generated multimodal feedback promote students' writing in collaborative Chinese language learning?
    2.1 How the learner engaging in collaborative Chinese language learning when processing AI-generated multimodal feedback?
    2.2 **How** AI-generated multimodal feedback promote students' enjoyment in collaborative Chinese language learning?

3. Methodology

3.1 Participants and intervention

The study will include four 2nd-grade classes (about 120 students) and their Chinese language teachers from two primary schools in Singapore. All students, aged 7 to 8, will have no prior experience with the learning system. Over eight weeks, students will participate in four 60-minute Chinese lessons, held every two weeks, involving collaborative activities and AI-generated multimodal feedback. After the lessons, all participants will complete a post-survey on their learning experiences and enjoyment. Additionally, eight student groups and four teachers will be interviewed to gather their perceptions of the AI-generated feedback.

3.2 Data collection and analysis

A series of analyses will be conducted to address the two research questions. To address RQ1, I will first examine whether AI-generated multimodal feedback enhances students' learning artifacts by analyzing the number and scores of group artifacts using descriptive analysis and t-tests. The same method will be applied to pre- and post- tests, to further investigate whether their academic achievement improves after the intervention. Additionally, I will apply content analysis to log data and screen recordings, based on Liu and Yu's model of three stages of students' learning behaviors when processing automated feedback (2022), to determine the level of usage of AI-generated multimodal feedback. One-way analysis of variance (ANOVA) will be employed to investigate whether the usage of AI-generated multimodal feedback affects the quality of group artifacts. Moreover, I will use survey results, along with the quantity and quality of artifacts, to investigate whether AI-generated multimodal feedback enhances students' learning enjoyment. Pearson correlation analysis will be applied to measure the strength and direction of the linear relationship between the number of group artifacts, the scores of group artifacts, and the enjoyment survey results. Meanwhile, multiple regression analysis will be used to determine how the number of group artifacts and the scores of group artifacts predict the enjoyment survey results.

To address the RQ2, I will apply network analysis to examine student learning who engaging in AI-generated multimodal feedback, investigate the relationships between various aspects of learner experiences, and evaluate the strengths and weaknesses of the designed learning activities. Clustered semantic network maps of young learners' experiences, in terms of feedback as information, feedback as an internal process, and feedback as social interaction, will be used to identify how various dimensions of AI-generated multimodal feedback are related and their impact. Next, post-interview data from students and teachers will be analyzed to explore students' enjoyment of learning activities. Thematic analysis will be employed to identify specific instances or types of feedback that students and teachers

discuss, and how these relate to students' enjoyment, with further links to teaching pedagogies.

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