

The Evolution of Learners' Interaction, Cognition, and Emotion in AI Digital Human-Mediated Learning

Yang Yang

International Department, Guangzhou College of Commerce, Guangzhou, China

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Abstract: This study explores how learners' interactional relationships, cognitive engagement, and emotional responses evolve through sustained interaction with an AI digital human in a vocational English writing course. A qualitative case study was conducted over six weeks, during which twelve students engaged regularly with an AI agent named Ava that provided feedback, prompts, and revision support. Data were collected from semi-structured interviews, weekly reflection journals, and system interaction logs. Thematic analysis revealed three core developmental trajectories: (1) Interactional Repositioning, where learners shifted from viewing Ava as a tool to perceiving her as a dialogic partner; (2) Emotional Realignment, marked by a transition from discomfort or skepticism to trust and empathy; and (3) Cognitive Reframing, where learners moved from surface-level editing to metacognitive writing awareness. These findings suggest that AI digital humans can play a relational role in shaping learners' emotional receptiveness and strategic thinking, particularly when interactions are consistent and socially embedded. The study contributes to a learner-centered understanding of AI-mediated learning and highlights the need to consider affective and cognitive development as intertwined processes in AI-supported education.

1. Introduction

The integration of artificial intelligence (AI) into educational environments has transformed how learners interact with digital systems, offering new pathways for feedback, engagement, and autonomy. Among emerging AI applications, AI digital humans, which are virtual agents equipped with natural language processing and human-like appearance or behavior, represent a novel form of instructional presence. These AI digital humans agents are increasingly used in language education to provide automated feedback, model conversation, and support learners' writing or speaking processes [13]. However, while the functionality of such systems has been explored extensively in terms of accuracy and performance, less is known about how learners' relationships with these agents evolve over time, particularly in affective and cognitive terms.

Existing research on AI in education has often adopted a technology-centered perspective, emphasizing usability, engagement metrics, or short-term learning gains [1]. Models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) focus on perceived usefulness and ease of use, but offer limited insight into

how learners make sense of AI agents over time, or how these interactions shape internal psychological processes. Recent calls within the field highlight the need for a more learner-centered approach that investigates not only behavior, but also the emotional and cognitive mechanisms underpinning AI-mediated learning [4].

In language learning contexts—especially in writing—interaction with AI tools often involves iterative dialogue, revision, and reflection. Learners engage with suggestions, assess relevance, and make decisions that reflect not only linguistic knowledge but also cognitive strategies and emotional reactions [7]. When the AI interface is embodied as a digital human, learners may perceive the agent not merely as a tool, but as a relational presence, capable of eliciting empathy, resistance, or even trust. These relational dynamics may influence how feedback is processed, how motivation is sustained, and how metacognition is activated across time. Yet, there remains a lack of empirical research that traces the temporal development of learners’ interactional, emotional, and cognitive trajectories in such settings.

To address this gap, this study explores how learners’ interactions with an AI digital human evolve during a six-week English writing course in a vocational college setting. Taking a qualitative, longitudinal case study approach, it investigates both observable behavioral changes and subjective meaning-making processes as learners repeatedly engage with a digital agent named Ava. Specifically, the study is guided by two research questions:

RQ1: How do learners’ interactional relationships with AI digital humans evolve over time in a learning context?

RQ2: What cognitive and emotional changes do learners experience throughout their interaction with AI digital humans?

By examining these questions, the study aims to contribute to a deeper understanding of AI-mediated learning as a developmental process rather than a fixed event. It seeks to illuminate how feedback, trust, and reflection unfold in interaction with an AI digital human—not only expanding theoretical models of learner-AI interaction, but also informing the pedagogical design of intelligent agents in language education.

2. Literature Review

2.1 AI Digital Humans in Language Learning

AI digital humans—also referred to as embodied conversational agents—simulate human-like interaction through language, gesture, and sometimes visual form. In language education, they have been applied in speaking practice, reading comprehension, and writing feedback [5]. Their potential lies in combining interactive dialogue with real-time scaffolding, potentially enhancing engagement and learning outcomes [6].

However, most research focuses on short-term performance indicators or learner satisfaction, overlooking how learners’ perceptions of these agents evolve over time. The emotional, relational, and developmental aspects of learner-AI interaction, especially in sustained learning contexts like writing, remains under examined.

2.2 Relational Dynamics in Learner-AI Interaction

Recent studies suggest that learners may attribute social presence or even peer-like status to AI agents, particularly when the interaction is sustained and personalized [11]. Over time, some learners shift from treating AI as a tool to engaging with it more dialogically, reflecting relational repositioning [8].

This evolving perception impacts how feedback is received and acted upon. When learners

perceive AI as credible or supportive, they may be more receptive and reflective. Yet, current frameworks like TAM or UTAUT rarely account for such relational dynamics, focusing instead on static constructs like usefulness or ease of use.

2.3 Emotional and Cognitive Engagement with AI Feedback

Emotions and cognition shape how learners process feedback. Negative affect, such as anxiety or confusion, can hinder uptake [9], while emotional trust facilitates deeper engagement [3]. In AI-mediated writing, learners often report mixed feelings—some find the feedback impersonal or difficult to interpret, while others report increased reflection when AI agents use more dialogic or supportive language [12].

Despite this, most studies offer cross-sectional insights. Few examine how learners' emotional and cognitive engagement with AI changes across repeated interactions, particularly in relation to trust, autonomy, and revision behavior.

In sum, prior research highlights the potential of AI digital humans to enhance language learning, yet often treats learner-AI interaction as static. The temporal evolution of learners' relational, emotional, and cognitive engagement remains a significant gap, particularly in writing contexts that demand sustained interaction and reflection. This study addresses that gap by qualitatively tracing how learners make sense of, relate to, and learn with an AI digital human over time.

3. Research Design

To explore how learners' interactional relationships with AI digital humans evolve and how their cognition and emotions shift over time, this study adopted a qualitative case study design. This methodology is particularly suitable for capturing the longitudinal, contextualized, and subjective experiences that underlie human-AI interaction in authentic learning environments. Drawing upon sociocultural theory [10], the study viewed the AI digital human as a mediational tool shaping learner development through social and semiotic interactions. Additionally, affective dimensions of second language learning [9] informed the inquiry into emotional responses during AI-mediated writing tasks.

The research was situated in a six-week blended English writing course at a higher vocational college in southern China. The AI digital human, referred to as Ava, was embedded as a learning companion across both in-class and out-of-class writing activities. Ava offered automated support through interactive feedback, dialogic prompts, and revision suggestions using both text-based and voice interaction channels. The system incorporated basic natural language understanding, turn-taking memory, and adaptive feedback features designed to simulate a peer-like presence. Rather than functioning solely as a tool, Ava acted as an interactional partner within the writing process.

Participants were selected using purposive sampling to ensure active engagement and consistent access to the AI system. Twelve students (6 female, 6 male) with mid-range English proficiency (CET-4 scores between 390-520) and moderate digital literacy were recruited based on their participation in a preliminary pilot test. All participants consented to sustained weekly use of Ava and demonstrated willingness to reflect on their experiences. Each student interacted with the AI at least twice per week through structured writing tasks across the six-week period.

Data were collected from three sources to capture cognitive, emotional, and behavioral dimensions of learners' interactional experiences. First, semi-structured interviews were conducted individually at three intervals: Week 1 (pre-intervention), Week 3 (midpoint), and Week 6 (post-intervention). Interview protocols explored learners' evolving perceptions of Ava, emotional reactions, preferred interaction strategies, and perceived cognitive outcomes (e.g., noticing, metacognition, revision depth). Second, participants submitted weekly written reflection journals

based on guided prompts, such as: “Describe one moment when interacting with Ava changed your view of writing,” or “How did Ava’s feedback make you feel this week?” These journals provided introspective accounts of emotional shifts, task engagement, and perceived progress. Third, system-generated interaction logs were collected, detailing timestamped usage frequency, time on task, and types of AI functions triggered. These behavioral traces were used to contextualize and triangulate self-reported data.

All interviews were audio-recorded, transcribed, and anonymized. Reflection journals and interaction logs were similarly de-identified and stored securely. Data analysis followed [2] six-phase thematic analysis protocol. All transcripts and journal entries were initially read for immersion, followed by inductive coding along three analytic dimensions: interactional patterns, emotional trajectories, and cognitive engagement. The coding process proceeded in three stages: (1) initial open coding of meaningful units across all data types; (2) grouping of related codes into subthemes; and (3) abstraction of higher-level themes through constant comparison across participants and data sources. Coding was managed using NVivo 14. Codes were iteratively refined, with particular attention to patterns of evolution, such as shifts from functional use to dialogic engagement, or from emotional discomfort to empathy toward the AI. Emerging stages included “initial resistance,” “functional accommodation,” “emotional alignment,” and “collaborative meaning-making.” These stages were validated through pattern-matching across sources and participants.

To enhance analytic rigor, 20% of the data corpus (selected across all three data types) was independently coded by a second researcher. Inter-coder agreement reached a Cohen’s kappa of 0.86, indicating strong reliability. Discrepant codes were discussed until full consensus was reached. Triangulation across interviews, journals, and system logs enhanced trustworthiness by integrating both subjective reflection and behavioral evidence.

4. Findings

Table 1 Overview of Themes, Descriptions, Codes, and Illustrative Quotes

Theme	Description	Representative Codes	Illustrative Quote
Interactional Repositioning	Evolution from tool-oriented use of the AI to relational or dialogic engagement	“One-way use”, “Task execution”, “Conversational trial”, “Co-construction”	“I rewrote my paragraph after Ava asked me to consider my audience. It’s like she was reminding me of my teacher’s voice.” (Lei, W6)
Emotional Realignment	Emotional trajectory from skepticism or detachment to trust and empathy	“Cold tone”, “Awkwardness”, “Support felt”, “Empathy”, “Relational comfort”	“Now I feel curious—sometimes I try to write something just to see how Ava will react.” (Hao, W3)
Cognitive Reframing	Shift from surface-level correction to reflective and metacognitive awareness	“Surface fix”, “Revision acceptance”, “Writing intention”, “Audience awareness”, “Self-questioning”	“I ask myself: is this really the best example? Before Ava, I didn’t do that.” (Ting, W6)

Through thematic analysis of interviews, reflection journals, and system interaction logs, three overarching themes were identified that captured how learners’ interactions with the AI digital

human evolved and how their emotional and cognitive states shifted over time: (1) Interactional Repositioning, (2) Emotional Realignment, and (3) Cognitive Reframing. These themes unfolded through distinct developmental phases, showing convergence across participants while also retaining individual variation. To provide an overview of the analytical structure, Table 1 summarizes each theme, its descriptive focus, representative codes, and an illustrative quote from the data.

4.1 Interactional Repositioning: From Tool Use to Social Alignment

In the early weeks, most learners positioned Ava as a functional tool, which is useful for task completion but perceived as rigid or impersonal. Many participants reported minimal engagement beyond issuing commands or receiving feedback.

“At first, I just typed in my essay and took whatever Ava gave me... like Google Translate, only smarter.” (*Ying, Week 1 Interview*)

However, by Week 3, a shift was observed in both discourse and interaction patterns. Learners began to experiment with conversational prompts, explore Ava’s clarifications, and occasionally personify the agent (“she helped me realize...”, “I felt she understood...”). Interaction logs showed increased session lengths (average rose from 5.3 minutes in Week 1 to 9.1 minutes in Week 3), with more learners using the “Ask for Explanation” function rather than simply “Accept Suggestion.”

By Week 6, half of the participants described Ava as a dialogic partner rather than a passive tool. Some likened the interaction to peer collaboration:

“I rewrote my paragraph after Ava asked me to consider my audience. It’s like she was reminding me of my teacher’s voice.” (*Lei, Week 6 Interview*)

The logs reflected this deepening engagement: five participants began initiating input (“What do you think of this sentence?”) instead of waiting for system prompts, suggesting a shift from compliance to co-construction.

4.2 Emotional Realignment: From Unease to Empathic Engagement

Emotionally, early interactions were characterized by awkwardness, skepticism, or indifference. Some learners found Ava’s tone “cold” or “too strict,” especially when confronted with numerous error flags or vague suggestions.

“When she underlined everything and said ‘Consider revising for clarity,’ I felt a bit useless.” (*Meng, Journal, Week 1*)

Several learners expressed frustration over perceived robotic behavior. However, emotional tone evolved significantly by mid-course. Reflection journals and midterm interviews noted growing curiosity, trust, and even amusement:

“Now I feel curious—sometimes I try to write something just to see how Ava will react.” (*Hao, Week 3 Interview*)

“She’s strict, but I get it now—it’s not criticism. It’s like... guidance.” (*Lina, Journal, Week 4*)

By Week 6, emotional responses showed increasing affinity. Participants reported feeling “less judged” and “more supported,” especially when Ava offered praise (“Good topic sentence!”) or remembered past inputs. This was particularly visible among less confident writers who initially feared automated feedback.

Two participants explicitly used affective language such as “I like working with her” or “Ava made me feel seen,” indicating an emotional bond rarely reported in early weeks. This empathic turn was interpreted as a form of emotional realignment—from resistance to affective openness—enabled by repeated, consistent interaction.

4.3 Cognitive Reframing: From Surface Fixes to Metacognitive Awareness

Cognitive changes were most evident in how learners described their writing decisions over time. In Week 1, many focused on surface-level corrections (e.g., grammar, word choice), treating Ava as a proofreading assistant.

“If she said it was unclear, I just rewrote it shorter. I didn’t think much beyond that.” (*Jun, Week 1 Interview*)

By Week 3, a growing number of participants began to articulate writing intentions, describe their audience, and evaluate Ava’s suggestions critically rather than accept them automatically.

“Sometimes I disagree. Like when she suggested I remove a rhetorical question—I kept it because it fit my tone.” (*Li, Journal, Week 3*)

“She made me think why I used that example. I guess I wasn’t sure myself before.” (*Chen, Week 3 Interview*)

This shift toward self-monitoring and justification marked the beginning of metacognitive awareness. By Week 6, learners referred to Ava as a “thinking partner” or “writing coach” rather than just a feedback machine. Several used language associated with self-regulation:

“Now I think more before I write—what Ava might comment on. It helps me plan ahead.” (*Ting, Week 6 Interview*)

“I ask myself: is this the best way to explain? Before Ava, I didn’t do that.” (*Fang, Journal, Week 6*)

System logs showed a notable increase in back-and-forth exchanges (up to 5–7 turns per session), especially in the final two weeks, suggesting deeper cognitive engagement and willingness to iterate on writing decisions.

4.4 Integrated Evolution: Temporal Patterns Across Dimensions

While the three themes are analytically distinct, they were deeply interconnected. Learners who initially displayed emotional resistance often also showed functional-only interaction and low cognitive involvement. Conversely, those who developed trust in Ava tended to explore dialogic prompts and engage in higher-order writing reflection. Table 2 presents the developmental stages of learners across interactional, emotional, and cognitive dimensions, as identified through longitudinal analysis.

Table 2 Stages of Learner Development Across Interactional, Emotional, and Cognitive Dimensions.

Developmental Stage	Interactional Mode	Emotional Orientation	Cognitive Focus
Initial Resistance (W1)	Tool-based, minimal exchange	Uncertainty, detachment	Surface editing
Functional Adaptation (W2–3)	Increased response use	Mild curiosity, reduced tension	Mixed-depth revision
Emotional Receptiveness (W3–4)	Dialogic trial use	Trust, empathy emerging	Writing intention articulation
Collaborative Engagement (W5–6)	Co-construction patterns	Confidence, enjoyment	Strategic planning, metacognition

These stages were not strictly linear, but most learners exhibited a temporal layering of change, with emotional openness often preceding cognitive deepening, and interactional experimentation acting as a bridge between the two.

5. Discussion

This study examined how learners' interactions with an AI digital human evolved over time, alongside their cognitive and emotional changes. The three emergent themes, Interactional Repositioning, Emotional Realignment, and Cognitive Reframing, reflect the developmental nature of human–AI relations in learning contexts.

Initially, learners positioned Ava as a task-oriented tool, but over time, began engaging with her as a dialogic partner. This shift illustrates mediated action, where digital agents function not just as instruments but as relational participants. Such repositioning is often overlooked in technology acceptance models that emphasize utility over relational dynamics. Our findings suggest that sustained interaction enables learners to reassign meaning and agency to AI, supporting more complex collaboration.

The emotional trajectory from detachment to trust further emphasizes the importance of affective factors in AI-mediated learning. Learners' discomfort early on reflects the affective filter hypothesis [9], where perceived coldness or overload can inhibit engagement. As familiarity grew, Ava was seen less as a critic and more as a supportive presence, particularly by lower-proficiency students. This emotional realignment enhanced learners' willingness to reflect and revise—echoing research on feedback literacy [3], which highlights the role of emotional receptiveness in uptake.

Cognitive change was most evident in the shift from surface-level editing to metacognitive awareness. Ava's prompts evolved from corrections to cognitive triggers, encouraging self-questioning and intentional planning—hallmarks of self-regulated learning. This reframing was often contingent on earlier affective openness, suggesting that emotional trust and interactional experimentation laid the foundation for deeper thinking.

Overall, the findings point to a layered pathway of development: interactional openness enables emotional realignment, which in turn supports cognitive reframing. In this light, AI digital humans should not be designed or studied solely as feedback tools, but as relational agents that co-shape learners' trajectories across emotional and cognitive domains.

6. Conclusion

This study investigated how learners' interactional relationships with an AI digital human evolved over time, and how these interactions shaped their cognitive and emotional experiences in a language learning context. Drawing on thematic analysis of interviews, reflection journals, and system logs, three core patterns were identified: Interactional Repositioning, where learners shifted from tool-based use to dialogic engagement; Emotional Realignment, reflecting a trajectory from initial discomfort to trust and empathy; and Cognitive Reframing, indicating a progression from surface-level revision to metacognitive awareness.

These findings contribute to emerging understandings of AI-mediated learning by highlighting the relational and developmental nature of learner, AI interactions. Rather than viewing AI digital humans as static tools, this study supports a more dynamic perspective: when consistently embedded in learning contexts, such agents can evolve into socially meaningful participants that facilitate both emotional openness and strategic thinking. This has practical implications for the design of AI in education—suggesting that relational features (e.g., feedback tone, memory of prior interaction) may be just as important as accuracy or functionality in promoting learner engagement.

Several limitations should be noted. The study was conducted in a single institutional setting with a small sample of vocational learners, which may affect transferability. While the longitudinal design captured temporal changes, it relied on self-report and system logs; more fine-grained interaction data (e.g., discourse analysis of real-time exchanges) could further enrich interpretation.

Future research could explore how individual learner traits, such as motivation, self-efficacy, or

cultural perceptions of AI, moderate these relational dynamics. Comparative studies across different AI agent types (e.g., text-only vs. embodied digital humans) may also clarify which design features best support affective and cognitive development. As AI continues to shape the learning landscape, understanding the evolving human, AI relationship will remain essential, not only for improving technology, but for deepening our understanding of learning itself.

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