

ARTICLE



Modelling students' emotional engagement in AI-augmented English reading: Mediation of AI learning interest and reading enjoyment

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Abstract

As an important development in CALL, artificial intelligence (AI)-assisted foreign language teaching not only offers unique advantages in leveled reading, vocabulary, pronunciation, self-assessment, personalized testing, and information retrieval but also effectively enhances learner interaction and emotional regulation in reading. Despite these advancements, research on learner emotional engagement in AI-augmented EFL reading instruction remains limited, and there is a lack of sufficient empirical understanding of the significance of learner interaction. This study constructs a predictive model for emotional engagement among EFL learners in AI-augmented educational contexts, aiming to analyze the impact of learners' AI literacy and peer interaction on their emotional engagement in reading. The research was conducted among 650 EFL university students in central China. Findings indicate that in AI-augmented EFL learning scenarios, learner AI literacy and peer learning interactions positively influence emotional engagement in reading. Furthermore, learner interest in AI use and reading pleasure play partial mediating and serial mediating roles in this relationship, respectively. This study not only highlights the critical role of AI literacy in AI-assisted EFL reading but also clarifies the significance of interpersonal communication for emotional engagement in AI contexts.

Keywords: emotional engagement; AI-augmented English reading; learning interest; enjoyment; AI literacy; interaction

Language(s) Learned in This Study: English

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Introduction

Student engagement, a complex construct integrating behavioral, cognitive, emotional, and social dimensions (Yang et al., 2021), is crucial for positive learning outcomes, with emotional engagement being a key predictor of academic success (Lu, G. et al., 2023). Despite their significance, accurately monitoring the dynamic fluctuations of engagement and emotion during reading tasks remains challenging (Lee, 2014). The antecedents of emotional engagement in reading contexts are still underexplored (Qiao et al., 2024), and research on predicting and regulating emotional engagement among reading learners is in its infancy (Liu, 2024). From a sociocultural perspective, student engagement is a socially mediated process where interactions with the environment and peers shape emotional and cognitive development. However, the application of sociocultural theory to emotional engagement remains underexplored.

The swift progress of computer and Internet technologies has cemented computer-assisted learning

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(CALL) as a cornerstone of contemporary university education. The human–computer interactive communication created by CALL exerts positive impacts on learners' emotional engagement and emotional states by providing personalized learning experiences, enhancing learner autonomy, reducing language anxiety, strengthening emotional involvement, and offering sustained motivation (Chen et al., 2024; Lo, 2025). This, in turn, catalyzes a transformation in language instruction. This evolution has facilitated extensive data collection on learners' emotional engagement (Kumar & Chong, 2018) and diversified learner interactions (Revell-Rogerson, 2021; Wei, 2022). As AI technologies gain traction in education, AI-assisted language teaching has become a pivotal segment of CALL, excelling in human–computer interaction, emotional change detection, and personalized learning plan generation (Namaziandost & Rezai, 2024). Yet, the application of sociocultural theory in AI-assisted education is nascent, with the fusion of technological innovation and sociocultural perspectives remaining underexplored. This gap hinders a comprehensive understanding of how to synergize social interactions and technological tools to amplify emotional engagement.

AI-driven EFL reading instruction enhances learning outcomes and autonomy through personalized, data-informed content and immediate, empathetic feedback, which reduces anxiety while boosting motivation and enjoyment (Çelik et al., 2024; Xin, 2024). These features foster a supportive, immersive environment that promotes intrinsic motivation and deeper emotional engagement with reading (Wang & Xue, 2024). However, over-reliance on technology in AIED (Artificial Intelligence in Education) can lead to an overestimation of AI's role in emotion regulation and a neglect of human interaction's crucial impact (Deng, 2023; Ye et al., 2024). Current AIED research often overlooks the emotional and social dimensions of learning. A more balanced approach, integrating technological and social elements, is needed to enhance emotional engagement.

This study merges Sociocultural Theory with Positive Psychology to probe how emotional engagement forms in AI-assisted EFL reading, spotlighting how learner interactions spur positive emotions. It applies these theories to AI education, examining how technological literacy and social interactions sculpt emotional engagement. The results underscore the vital interplay of human interaction and positive emotions in human-AI learning. Notably, it fills a research gap by spotlighting peer interactions' role in boosting emotional engagement, thus deepening our grasp of the combined impact of social dynamics and technological literacy on positive learning outcomes in AI education.

Literature Review

AI Literacy

AI literacy involves the ability to critically evaluate AI technologies, communicate effectively with AI, and utilize AI as a tool in various settings (Liu & Fan, 2025; Zhang et al., 2025). This concept is essential as it encompasses both technical skills and the ethical and responsible use of AI technologies (Dignum, 2019). AI literacy can be categorized into four dimensions: understanding fundamental AI concepts, applying these concepts in practical contexts, critically evaluating AI technologies, and comprehending the ethical implications of AI applications (Cox, 2024; Wang et al., 2025). AI literacy has been shown to enhance learners' self-efficacy, stimulate positive learning emotions, and improve learning outcomes (Al-Abdullatif & Alsubaie, 2024; Yim & Su, 2024).

AI Learning Interest

Learning interest is a crucial component of educational psychology, widely discussed across various disciplines (Tohir, 2022). Characterized by attention, effortless engagement, and feelings of pleasure, learning interest is pivotal in English education, as it is essential for engaging students and enhancing their creative thinking skills (Gayatri & Sit, 2024; Liu, 2026).

In the era of comprehensive AI empowerment, learners' AI learning interest is essentially a situational interest triggered by specific contextual factors. It is a prerequisite for overcoming AI technology fears

and difficulties and is key to sustaining AI-assisted learning (Lee, 2021). Research on learners' AI learning interest is still in its infancy, with limited studies exploring its relationship with learning emotions and outcomes.

Learner Interaction

Learner interaction is a multifaceted construct that broadly encompasses learners' active engagement in communication, collaboration, and participation within the learning environment (Alharbi, 2018; Lin et al., 2021). It can be categorized into several forms, including teacher-student interaction, student-student (peer) interaction, and learner-content interaction (e.g., interaction with learning resources or technological tools). In the context of the present study, and in alignment with its sociocultural theoretical underpinnings (see Section 2.6), the focus is specifically on peer interaction or student-student interaction. This conceptual narrowing is deliberate and critical. Vygotsky's (1978) Sociocultural Theory posits that higher-order cognitive and affective development is fundamentally mediated through social dialogue and collaborative activities with others. From this perspective, peer interaction serves as a primary mechanism for scaffolding, mutual feedback, and the co-construction of understanding, fostering critical thinking and problem-solving skills (Vygotsky, 1978). Therefore, within the AI-augmented reading classes examined here, "learner interaction" is operationalized as the extent and quality of collaborative exchanges among students as they engage with AI tools and complete shared reading tasks.

With the integration of artificial intelligence into educational settings, the ecology of interaction has expanded to include learner-AI interaction (Seo et al., 2021). While this human-computer dynamic offers new avenues for personalized learning, it also raises ethical considerations regarding privacy, surveillance, and the potential constraint of student creativity (Wogu et al., 2018). To mitigate such risks and counter a purely techno-centric approach, this study emphasizes the indispensable role of human social interaction even within technology-rich environments. A human-in-the-loop approach, where peer collaboration and instructor guidance remain central, is essential for holistic learning (Baker, 2016).

Reading Enjoyment

Reading enjoyment significantly influences reading comprehension and academic performance, thus attracting considerable research focus (Kruk et al., 2024). Reading enjoyment is a complex construct influenced by multiple factors, including gender, socioeconomic status, educational track, and language background. Social interactions related to reading can enhance reading enjoyment and support the development of reading skills (Studdert & Walkerdine, 2016). The advent of information technology and the digital revolution have transformed reading habits. Some scholars argue that digital reading provides new avenues for engagement and interaction (Ozturk & Hill, 2020). However, there remains a notable gap in research exploring how learner interactions evolve and their impact on engagement in AI-supported reading contexts, particularly those mediated by AI-generated content (Liu et al., 2024; Liu et al., 2025).

Emotional Engagement

Emotional engagement refers to learners' positive emotional reactions to instructional contexts, teachers, and peers, such as enjoyment, excitement, and enthusiasm (Bond & Bedenlier, 2019; Svalberg, 2009). It is one of three dimensions of learner engagement, alongside behavioral and cognitive engagement (Skinner et al., 2009). This dimension inherently involves social interaction. Compared to traditional learning, online environments often lack immediate feedback and social support, which are critical for emotional engagement (Dewaele et al., 2024). Similarly, AI-enhanced distance education lacks the conditions to stimulate positive emotional engagement compared to face-to-face learning. Given that AI-assisted English learning is still emerging, research on emotional engagement in EFL reading within AIED contexts is both timely and necessary.

Theoretical Framework and Hypotheses

Lev Vygotsky's Sociocultural Theory (SCT) highlights the pivotal role of social interaction in learning and development. Learning, according to Vygotsky, transpires via interactions with more knowledgeable

individuals within a social milieu, underscoring the significance of cultural tools like language in mediating cognitive processes and the Zone of Proximal Development (ZPD) (Vygotsky, 1978). In this study, AI-augmented reading software is conceptualized as a “cultural tool” within the SCT framework. According to Vygotsky, cultural tools (e.g., language, writing, signs) are artifacts created by society to mediate human thinking, communication, and problem-solving (Vygotsky, 1978). AI reading software functions as a contemporary, intelligent tool that extends this notion by mediating the reading process in several key ways: it (a) provides adaptive and personalized content, acting as a cognitive scaffold; (b) offers immediate feedback and clarification, serving as an interactive partner that simulates tutorial dialogue; and (c) structures and represents knowledge (e.g., through concept maps), acting as a semiotic organizer. Thus, the software is not merely a technological device but a culturally embedded mediator that shapes how learners access, interpret, and internalize reading materials. Concurrently, student-to-student (peer) interaction forms a “social collaboration space,” providing essential social scaffolding through discussion, negotiation, and emotional support. AI literacy signifies an individual’s proficiency in using this advanced cultural tool effectively, while peer interaction denotes the density and quality of human social scaffolding. Together—through the dual mediation of the technological tool and social collaboration—they enter and expand the learner’s ZPD, triggering AI learning interest and reading enjoyment, thereby fostering heightened emotional engagement. This elucidates the interactive mechanism underlying the path “AI literacy × peer interaction → mediating variables → emotional engagement.”

Positive Psychology, which emerged in the late 1990s, has spurred researchers to explore how positive emotions and traits can enhance learning outcomes, particularly in second language acquisition (SLA) and EFL teaching (MacIntyre et al., 2019). Constructs like foreign language enjoyment and mindfulness have been shown to improve learning outcomes and student well-being (Namaziandost & Rezai, 2024). When AI-empowered reading activates positive emotions such as AI learning interest and reading enjoyment, it can expand learners' cognitive and behavioral resources through the Broaden-and-Build effect, ultimately manifesting as deep emotional engagement. This theory complements Sociocultural Theory's limited focus on the emotional dimension, enabling the model to explain why the same AI tool can produce different levels of engagement under varying emotional states.

In virtual learning environments facilitated by human-computer interaction, especially those enhanced by AI, interpersonal interactions are frequently neglected (Wang, 2024). Against this backdrop, the current study integrates Sociocultural Theory with Positive Psychology to examine how interactive communication affects learners' emotional engagement in English reading classes within the framework of Artificial Intelligence in Education (see [Figure 1](#)).

Existing research indicates that literacy education is a process of growing interest, with interest enhancement being a key objective of literacy education (Chen et al., 2024; Wang et al., 2022). The formation and enhancement of learners' interest are influenced by interactions with others; for example, interpersonal interactions are crucial for children's positive emotions in English learning (Gu et al., 2008). In virtual learning environments, computer-simulated human-human interactions significantly enhance students' learning interest (Sha, 2009).

Therefore, we propose the following hypotheses:

H1a: EFL learners' AI literacy positively affects their AI learning interest.

H1b: EFL learners' interaction positively affects their AI learning interest.

In the context of AI-assisted reading, Tram et al. (2024) demonstrated that proficient use of AI tools such as ChatGPT can effectively enhance learners' reading pleasure. Additionally, while reading can be an individual activity, interactions and writing related to reading undoubtedly enhance interest and positive experiences. Moreover, with the increasing prevalence of ICT-assisted and digital reading, research has further confirmed that learners' affinity and interest in new reading technologies in non-traditional reading contexts can facilitate positive reading experiences and evaluations (Anton et al., 2013; Huang & Zhang,

2024). Therefore, this study proposes the following hypotheses:

H2a: EFL learners' AI literacy positively affects their reading enjoyment.

H2b: EFL learners' interaction positively affects their reading enjoyment.

H2c: EFL learners' AI learning interest positively affects their reading enjoyment.

Learners' interest in reading, such as intrinsic interest and proximal situational interest, plays a crucial role in their emotional engagement during reading (Arapakis et al., 2019). Additionally, research has confirmed that the use of technology in reading can enhance learners' emotional engagement. For example, the use of touchscreen technology can increase emotional engagement in reading activities (Ross et al., 2016). Moreover, collaborative classroom interactions, such as feedback and discussion, have been found to effectively enhance learners' enthusiasm and focus during reading (Zhu et al., 2021). Despite the continuous enrichment of reading contexts driven by information technology, studies have found that social interaction remains an important positive influence on learners' emotional engagement in multimedia or virtual reading instruction (Jin et al., 2022). Hence, we propose the following hypotheses:

H3a: EFL learners' AI literacy positively affects their emotional engagement.

H3b: EFL learners' interaction positively affects their emotional engagement.

H3c: EFL learners' reading enjoyment positively affects their emotional engagement.

H3d: EFL learners' AI learning interest positively affects their emotional engagement.

In recent years, with the development of online teaching, learning interest has been shown to partially mediate the relationship between online interaction and academic engagement (Zhang & Zhang, 2024). Additionally, reading enjoyment is a common mediating variable in educational research, often mediating the relationship between external stimuli (such as teacher support and feedback) and reading achievement (Ma et al., 2024). Based on the above, the following hypotheses are proposed in this study:

H4a: EFL learners' AI learning interest mediates the relationship between AI literacy and learners' emotional engagement.

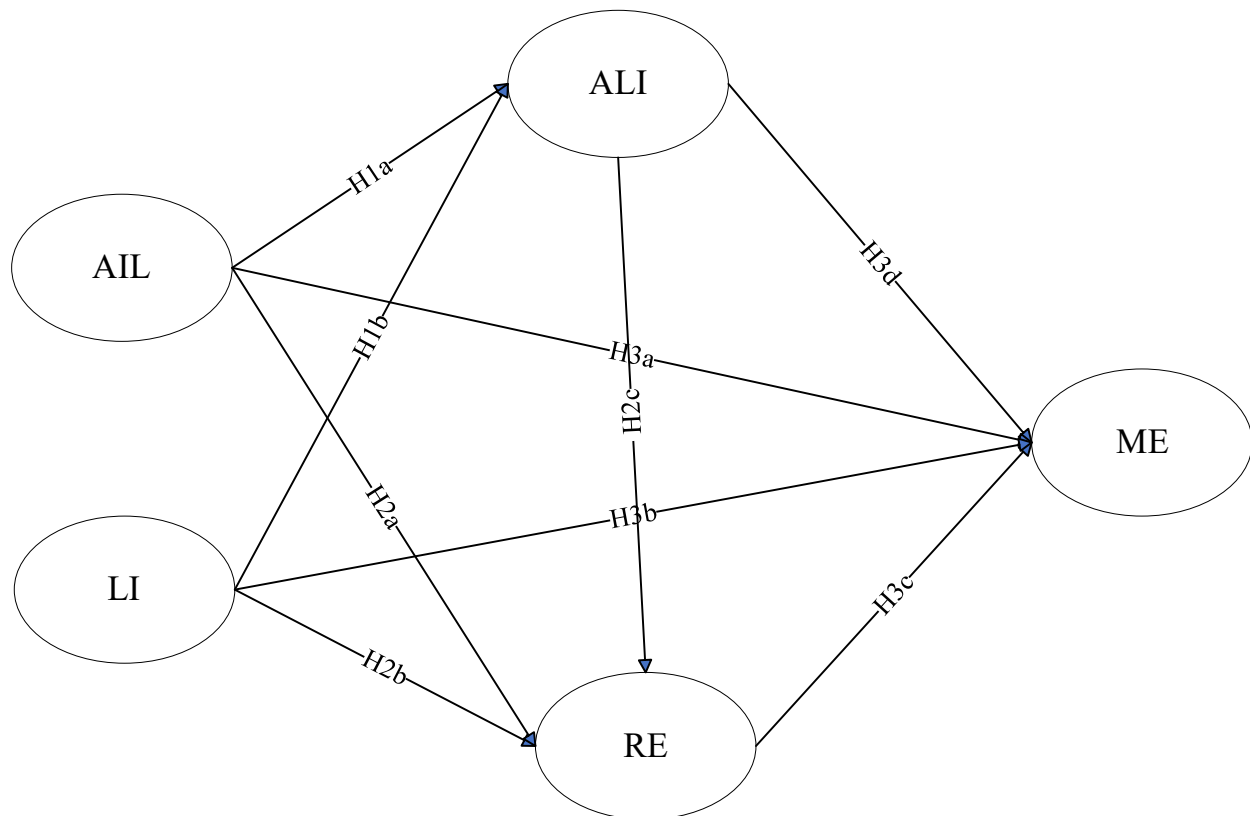
H5b: EFL learners' reading enjoyment mediates the relationship between learners' interaction and learners' emotional engagement.

H5a: EFL learners' reading enjoyment mediates the relationship between AI literacy and learners' emotional engagement.

H4b: EFL learners' AI learning interest mediates the relationship between learners' interaction and learners' emotional engagement.

H6a: EFL learners' AI learning interest and reading enjoyment play a sequential mediating role in the relationship between AI literacy and learners' emotional engagement.

H6b: EFL learners' AI learning interest and reading enjoyment play a sequential mediating role in the relationship between learners' interaction and learners' emotional engagement.

Figure 1*Research Model*

Note. LI : learner interaction ; ALI : AI learning interest ; AIL : AI literacy ; RE : reading enjoyment ; ME : emotional engagement.

Method

Sampling and Data Collection Procedures

The study sample consisted of 629 English as a Foreign Language learners from a total of eight undergraduate institutions across three provinces (Hubei, Anhui, and Henan) in central China. These institutions were selected to represent four distinct types within the Chinese higher education system: (1) two comprehensive (“Double First-Class”) universities, (2) two provincial key universities, (3) two ordinary public undergraduate institutions, and (4) two applied technology universities. Data were collected from a total of 24 intact College English classes (approximately 3 classes per institution on average) during their regularly scheduled reading sessions in the spring semester of 2024. This sampling strategy aimed to capture a diverse yet structured representation of the EFL learner population in the region.

The participants were first- and second-year undergraduates admitted via the National College Entrance Examination (Gaokao). To ensure a comparable baseline in English proficiency, selection was based on institutional academic placement: all were enrolled in the mainstream “College English” track, determined by standardized placement tests upon entry. Enrollment in this track indicated foundational skills for intermediate-level academic reading. Second-year participants had completed first-year College English; first-year participants were midway through the same sequence.

The English Reading courses were credit-bearing, mandatory components of the curriculum, meeting

twice weekly for 90 minutes (a standard two-credit-hour structure). The primary goal was to develop comprehensive reading proficiency, including fluency, academic vocabulary, critical reading strategies, and text analysis. While materials varied slightly, all classes used a standardized nationally-published integrated skills textbook (New Horizon College English or Experiencing English series). The AI-augmented activities were supplementary modules. During the spring semester of 2024 (early March to mid-July), classes integrated AI-enhanced software as a bi-weekly module within the 16-week semester. Under instructor guidance, participants primarily used “Reading Coach,” complemented by Chaoxing Learning (Xuexitong). AI sessions were conducted during scheduled class time, with brief preparatory or follow-up tasks assigned occasionally. All tasks were formally assigned by instructors, but the AI system handled real-time automated evaluation (e.g., fluency, quiz accuracy).

Before each session, Reading Coach generated three versions of a text (300–500 words, expository or argumentative, CEFR B1–B2) tailored to each learner’s level. Within the first 5 minutes of class, small groups voted on their preferred version via Chaoxing. During reading, the software provided personalized annotations and analyzed fluency via voice-to-text. At intervals, it posed AI-generated comprehension questions requiring short oral responses with automated clarification. Immediately after reading, it generated interactive concept maps. Each student then produced a 60-second English vlog summary or reflection, uploaded to Chaoxing for peer feedback (likes, query emojis) and instructor review. The AI also provided valence-arousal scores based on vocal tone and pacing during reading aloud.

While Reading Coach was primary, students could autonomously use supplementary AI tools (e.g., eJOY, Kimi, Doubao) during designated exploration periods. At semester’s end, following all AI-augmented activities and final assessments, the survey was administered electronically via WeChat. Participants were recruited through convenience sampling; ethical approval and informed consent were obtained.

Instruments were not translated. In early August 2024, a QR code was sent to 650 EFL students; 629 valid responses were collected after two weeks (96.7% response rate), with no missing data.

The sample consisted of 167 males (26.6%) and 462 females (73.4%). In terms of academic year, 178 university freshmen (28.3%) and 451 sophomores (71.7%) participated in the survey. Regarding the use of AI tools in reading instruction, 95 respondents (15.1%) used one AI tool to assist with English reading practice; 127 participants (20.2%) used two AI tools; 284 participants (45.2%) used three AI tools; and 123 participants (19.6%) used four or more AI tools (see Table 1).

Table 1

Demographic Statistics (N = 629)

Variables		Frequency	Percentage (%)
Gender	Male	167	26.6
	Female	462	73.4
Grade	Freshman	178	28.3
	Sophomore	451	71.7
Types of AI tools used	One	95	15.1
	Two	127	20.2
	Three	284	45.2
	Four and above	123	19.6

Instruments

The constructs examined in this study encompass artificial intelligence literacy (AIL), reading enjoyment (RE), AI learning interest (ALI), learner interaction (LI), and emotive engagement (EE). All items were assessed using a 5-point Likert scale, ranging from 1 (“Strongly Disagree”) to 5 (“Strongly Agree”) (see

Appendix A).

Artificial Intelligence Literacy

The present study utilized the artificial intelligence literacy scale developed by Chai et al. (2020) to assess participants' AI literacy. In the present study, the scale primarily assessed learners' comprehension, critical evaluation skills, and effective utilization of AI technologies, such as Reading Coach. This scale consists of six items (e.g., "I understand why AI technology requires big data."). In this study, the Cronbach's α value for AI literacy was 0.918, indicating high internal consistency.

Learner Interaction

This latent variable was measured using a scale developed by Rautela et al. (2024) to assess learner interaction in AI-supported EFL reading classes. The scale is primarily designed to measure the extent to which learners interact with their peers during AI-assisted foreign language learning. Its scale comprises four items (e.g., "I interact with other students regarding course content."). In this study, the Cronbach's α coefficient for the scale was 0.877, indicating satisfactory internal consistency. The measure aimed to capture how learners worked together, shared insights, and supported each other, highlighting the role of social dynamics in enhancing the learning experience. By examining learner interaction, the study sought to understand how collaborative activities facilitated by AI can influence emotional engagement and overall learning outcomes.

AI Learning Interest

The continuance intention for AI-assisted EFL learning was assessed using the AI learning interest scale developed by Zhong et al. (2021). In the present study, the scale was primarily employed to measure learners' level of interest in engaging with AI technologies, such as Reading Coach. It comprises four items, such as "It is interesting to practice practical AI tasks in the AI-supported course." In this study, the Cronbach's α value for the scale was 0.947, indicating a high level of internal consistency. This scale is crucial as it helps to understand how motivated learners are to interact with AI and how this interest might influence their learning outcomes and engagement.

Reading Enjoyment

The current study utilized the scale developed by Zhong et al. (2021) to assess the extent to which learners experience positive emotions and pleasure while engaging in AI-assisted reading activities. The scale consists of six items (e.g., "My enjoyment of the reading made me proceed."). In this study, the Cronbach's α value for the scale was 0.928, indicating robust internal consistency. This measure is essential for understanding how AI technologies can enhance the reading experience and contribute to a more engaging and enjoyable learning environment.

Emotional Engagement

In this study, the researchers employed the emotional engagement scale developed by Hamedi et al. (2020) to assess the depth and intensity of learners' emotional responses and connections while participating in AI-assisted English reading activities. The scale comprises six items (e.g., "I looked forward to continuing reading it."). The Cronbach's α value for the scale was 0.939, indicating high internal consistency. By examining emotional engagement, the study aimed to understand how AI technologies can influence learners' emotional states and contribute to a more immersive and effective learning environment.

Data Analysis

This study employed SPSS 26.0 and AMOS 24.0 for data analysis. Initially, Harman's single-factor test was conducted to assess and mitigate common method bias due to the reliance on self-reported measures. Subsequently, descriptive statistics and correlation analyses were performed to provide an overview of the collected data. The hypothesized model was then tested, and the results of the regression analysis were

reported. Finally, mediation effects were examined using a bootstrapping approach to generate a bias-corrected 95% confidence interval.

Results

Descriptive and Correlation Analysis

Table 2 provides the mean values, standard deviations, and correlation coefficients for the latent variables. All variables showed acceptable skewness and kurtosis levels (below the recommended thresholds of 2 and 7, respectively). The latent variables had positive and significant relationships, with correlations below the multicollinearity threshold of 0.85 (Hair et al., 2019). Thus, the data are suitable for further statistical analysis.

Table 2

Descriptive Statistics, Correlation, and AVE Square Roots

	AIL	LI	ALI	RE	ME
AIL	0.808				
LI	0.498**	0.801			
ALI	0.254**	0.250**	0.867		
RE	0.479**	0.479**	0.267**	0.827	
ME	0.280**	0.306**	0.279**	0.368**	0.849
Mean	3.442	2.602	3.022	3.437	3.312
SD	1.113	0.845	0.795	0.744	0.841
Skewness	-0.480	-0.518	0.704	-0.797	-0.854
Kurtosis	-0.971	-0.938	-0.164	0.837	0.418

Note. ** $p < 0.01$; SD=Standard Deviation; LI: learner interaction; ALI: AI learning interest; AIL: artificial intelligence literacy; RE: reading enjoyment; ME: emotive engagement.

Common Method Bias

This study surveyed EFL students from four local universities using questionnaires adapted from previous research. To ensure that common method bias did not distort the data, Harman's single-factor test was conducted (Podsakoff et al., 2003). The results of the test revealed four factors with initial eigenvalues exceeding 1. The variance explained by the first factor was 30.88%, which is well below the critical threshold of 40%. This finding indicates that common method bias is not a significant concern in the collected data.

Measurement Model Analysis

The measurement model includes four key components: item reliability, internal consistency reliability, convergent validity, and discriminant validity. All item factor loadings exceeded the recommended threshold of 0.50 (Hair et al., 2014), indicating satisfactory item-level reliability. Cronbach's alpha (α) and composite reliability (CR) values were above 0.800 (see Appendix B), confirming high internal consistency reliability (Hair, 2019). Convergent validity was confirmed with average variance extracted (AVE) values of 0.5 or above for each construct (Hair et al., 2014). Discriminant validity was supported as AVE estimates for each factor pair exceeded the squared correlation between them (see Table 2).

Test for Structural Model

This study constructed a structural model with learners' AI literacy (AIL) and learner interaction (LI) as antecedent variables, AI learning interest (ALI) and reading enjoyment (RE) as mediating variables, and

emotional engagement (ME) in EFL reading as the outcome variable (as shown in Fig. 1). The model fit indices indicated that the model demonstrated good fit: $\chi^2 = 505.575$, $df = 340$, $\chi^2/df = 1.475$, GFI = 0.948, AGFI = 0.937, CFI = 0.988, TLI = 0.987, IFI = 0.988, RMSEA = 0.027, and SRMR = 0.028.

The study conducted regression analyses focusing on AI learning interest (ALI), reading enjoyment (RE), and emotional engagement (ME) respectively. Table 3 and Figure 2 revealed the results of the analysis which showed that: learners' AI literacy (AIL) and learner interaction (LI) significantly and positively influenced ALI ($\beta = 0.172$, $p < 0.001$; $\beta = 0.164$, $p < 0.01$), thereby supporting Hypothesis 1a and Hypothesis 1b. AIL and LI also significantly and positively affected RE ($\beta = 0.300$, $p < 0.001$; $\beta = 0.301$, $p < 0.001$), supporting Hypothesis 2a and Hypothesis 2b. ALI significantly and positively influenced RE ($\beta = 0.116$, $p < 0.01$), supporting Hypothesis 2c. Regarding the direct effects of the model, AIL did not significantly predict ME ($\beta = 0.066$, $p = 0.180$), while LI significantly predicted ME ($\beta = 0.118$, $p < 0.05$). Therefore, Hypothesis 3a was rejected, and Hypothesis 3b was accepted. Both RE and ALI significantly and positively affected ME ($\beta = 0.235$, $p < 0.001$; $\beta = 0.170$, $p < 0.001$), supporting Hypothesis 3c and Hypothesis 3d.

Table 3

Research Model Regression Weight and Hypotheses

DV	IV	B	S.E.	B/S.E.	β	P-value	R ²	Hypothesis	Result
ALI	AIL	0.133	0.038	3.511	0.172	***	0.085	H1a	Supported
	LI	0.128	0.039	3.279	0.164	0.001		H1b	Supported
	AIL	0.190	0.029	6.604	0.300	***		H2a	Supported
RE	LI	0.193	0.030	6.492	0.301	***	0.32	H2b	Supported
	ALI	0.095	0.031	3.062	0.116	0.002		H2c	Supported
	RE	0.282	0.059	4.788	0.235	***		H3c	Supported
ME	ALI	0.167	0.040	4.418	0.170	***	0.188	H3d	Supported
	AIL	0.050	0.038	1.340	0.066	0.180		H3a	Rejected
	LI	0.091	0.039	2.329	0.118	0.020		H3b	Supported

Note. *** $p < 0.001$ DV: Dependent Variables; IV: Independent Variables; LI: learner interaction; ALI: AI learning interest; AIL: artificial intelligence literacy; RE: reading enjoyment; ME: emotional engagement.

This study examined the mediating roles of AI learning interest (ALI) and reading enjoyment (RE) in the influence of AI literacy (AIL) and learner interaction (LI) on emotional engagement (ME) (see table 4). ALI significantly mediated the effects of AIL and LI on ME. The indirect effect of AIL on ME through ALI was significant (point estimate = 0.022, standard error = 0.009, $Z = 2.750$, 95% confidence interval = [0.009, 0.042], $p < 0.001$), supporting H4a (AIL \rightarrow ALI \rightarrow ME). Similarly, the indirect effect of LI on ME through ALI was significant (point estimate = 0.021, standard error = 0.009, $Z = 2.625$, 95% confidence interval = [0.009, 0.040], $p < 0.001$), supporting H4b (LI \rightarrow ALI \rightarrow ME).

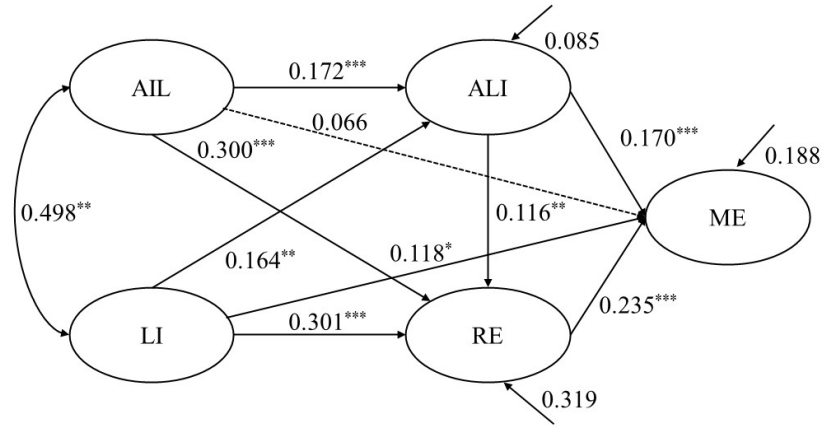
RE also significantly mediated the effects of AIL and LI on ME. The indirect effect of AIL on ME through RE was significant (point estimate = 0.054, standard error = 0.017, $Z = 3.176$, 95% confidence interval = [0.026, 0.092], $p < 0.001$), supporting H5a (AIL \rightarrow RE \rightarrow ME). The indirect effect of LI on ME through RE was significant (point estimate = 0.054, standard error = 0.017, $Z = 3.176$, 95% confidence interval = [0.027, 0.095], $p < 0.001$), supporting H5b (LI \rightarrow RE \rightarrow ME).

Further analysis revealed significant chain mediating effects of ALI and RE. The chain mediating effect of AIL on ME through ALI and RE was significant (point estimate = 0.004, 95% confidence interval = [0.001, 0.009], $p < 0.002$), supporting H6a (AIL \rightarrow ALI \rightarrow RE \rightarrow ME). Similarly, the chain mediating

effect of LI on ME through ALI and RE was significant (point estimate = 0.003, 95% confidence interval = [0.001, 0.009], $p < 0.002$), supporting H6b (LI → ALI → RE → ME).

Figure 2

Structural Model



Note. $\chi^2/df = 1.475$, $GFI = 0.948$, $AGFI = 0.937$, $IFI = 0.988$, $RMSEA = 0.027$, $CFI = 0.988$, and $TLI = 0.987$

LI: learner interaction; ALI: AI learning interest; AIL: artificial intelligence literacy; RE: reading enjoyment; ME: emotional engagement.

Table 4

Mediation Analysis

Path	Point Estimate	Product of Coefficient		Bootstrapping Bias-Corrected 95% CI		
		SE	Z-value	Lower	Upper	P-value
Ind1 (AIL-ALI-ME)	0.022	0.008	2.750	0.009	0.042	0.001
Ind2(LI-ALI-ME)	0.021	0.008	2.625	0.009	0.040	0.001
Ind3(AIL-RE-ME)	0.054	0.017	3.176	0.026	0.092	0.000
Ind4(LI-RE-ME)	0.054	0.017	3.176	0.027	0.095	0.000
Ind5(AIL-ALI-RE-ME)	0.004	0.002	2.000	0.001	0.009	0.002
Ind6(LI-ALI-RE-ME)	0.003	0.002	1.500	0.001	0.009	0.002
Direct1(AIL-ME)	0.050	0.042	1.190	-0.031	0.134	0.213
Direct2(LI-ME)	0.091	0.041	2.220	0.013	0.172	0.022

Discussion

Grounded in Sociocultural Theory and Positive Psychology, this study posits AI literacy and student-to-student interaction as dual drivers of learners' emotional engagement, with AI learning interest and

reading enjoyment serving as positive emotional constructs emerging from social interactions and ultimately pointing to emotional engagement as a higher-order developmental outcome.

Impact of AI Literacy and Learner Interaction on AI Learning Interest

Sociocultural Theory posits that individuals' cognitive development and interest formation are realized through social interactions and the use of cultural tools. In this study, the positive impact of AI literacy (AIL) on AI learning interest (ALI) is empirically supported. This finding aligns with Stolpe and Hallstrom (2024), who found that AI literacy education significantly increases learners' interest in learning and their willingness to use AI technologies. In this study, after mastering the use of AI-assisted reading tools, learners were able to complete reading tasks more efficiently. This positive learning experience encouraged them to continue exploring and using AI technologies, thereby increasing their interest in AI learning.

Moreover, this study finds that learner interaction significantly enhances learners' AI learning interest. Previous studies have shown that social interaction can significantly increase learners' interest in cognitive activities (Rotgans and Schmidt, 2011). In the present study, learners, in reading group discussions, enhance their interest and motivation in AI learning by sharing and exploring new AI applications and technical problem-solving strategies. At the same time, the supportive learning environment created by learner interaction makes them feel understood and encouraged, and this positive emotional experience further increases their interest in AI learning. It is in line with the Positive Psychology which argues a supportive environment can enhance learners' positive emotions and promote their interest in learning (Seligman, 2011).

Impact of AI Literacy, Learner Interaction, and AI Learning Interest on Reading Enjoyment

The present study finds that AI literacy directly influences reading enjoyment. This finding is consistent with Liu and Fan (2025), who found that AI literacy can significantly boost their pleasure during the learning process. In this study, AI functions like smart translation and text analysis enabled learners to more efficiently understand and absorb reading materials, enhancing reading pleasure and reducing frustration from language or comprehension issues. Additionally, this study empirically confirms that interpersonal interactions positively affect learners' positive emotions in AI-assisted reading. According to Sociocultural Theory, peer interactions foster a positive and enjoyable learning environment, enhancing learning efficiency. (Kibler, 2017). In this study, the exchange of diverse perspectives among peers enlivens the reading process and stimulates learners' interest.

Furthermore, this study also finds a positive relationship between learners' ALI and their RE. In traditional learning modes, learners' interest is closely linked to their pleasurable learning experiences (Y. Lu et al., 2023). From a positive psychology standpoint, interest and enjoyment, as key positive emotions, bolster learners' intrinsic motivation and engagement (Seligman, 2011). Learners' curiosity about AI technology prompts exploration of reading assistance functions, which enhances reading enjoyment and interest. In AI-assisted foreign language reading, learner interaction and AI learning interest synergistically boost reading pleasure.

Mediating Role of Learners' AI Learning Interest and Reading Enjoyment

The study also reveals that learners' AI literacy does not directly and significantly influence their emotional engagement in reading. This aligns with Standen et al. (2020), who argued that technological cognitive advantages must translate into emotional benefits to foster engagement. Even if learners possess high AI literacy, the absence of positive emotional feedback from AI tools during the reading process, such as interest, pleasure, or a sense of achievement, makes it unlikely for this technological literacy to translate into emotional engagement. This study reveals two coherent pathways in the transformation from technological literacy to emotional engagement: AIL fully mediates ME through ALI, sparking learners' intrinsic curiosity about AI tasks, and through RE, consolidating emotional engagement via

technology-enhanced reading pleasure.

Unlike the full mediation effect of AI literacy, learner interaction has a dual-channel effect, directly influencing emotional engagement and indirectly affecting it through AI learning interest and reading enjoyment. This finding aligns with Dao (2020) and Derakhshan et al. (2024), who identified peer interaction as a core trigger for foreign language engagement. It also supports Kibler's (2017) concept of “emotional scaffolding”, where interaction provides a sense of belonging and immediate feedback, directly boosting engagement. Simultaneously, peer collaboration in using AI tools amplifies interest and pleasure, creating a cyclical interaction-emotion-reinteraction loop. From a Positive Psychology perspective, this interaction enhances positive emotions, social support, and belonging, thus promoting emotional engagement (Seligman, 2011).

Additionally, this study identifies a chain mediating effect of AI learning interest and reading enjoyment. According to Sociocultural Theory, interest—a primary emotion—prompts regular use of AI tools, which in turn provides immediate feedback and personalized support. This process leads to stable reading pleasure and ultimately results in increased emotional engagement. This aligns with Positive Psychology's view that positive emotions, through feedback loops, cumulatively boost long-term development (Fredrickson, 2001). The ALI→RE sequence is significant, irrespective of the starting point, forming an "interest-enjoyment" chain that refines the emotional ladder model for both theories.

Conclusion

This study underscores the importance of integrating AI literacy and learner interaction to enhance emotional engagement in AI-assisted foreign language reading. Universities and teachers should prioritize interactive activities that promote peer collaboration and a positive learning environment. Such an approach not only fosters emotional engagement but also aligns with Sociocultural Theory, which highlights the role of social interaction in cognitive and emotional development. Educators should also integrate AI literacy into the curriculum to help students adapt to new technologies and improve their confidence in using AI tools, thereby enhancing their overall learning experience.

The findings indicate that AI literacy alone does not directly influence emotional engagement; instead, learners' interest in AI and positive emotions play a significant mediating role. Therefore, EFL learners should balance AI use with peer interactions to avoid over-reliance on technology and create a supportive learning community. This balance is crucial for maintaining engagement and fostering a positive learning environment, as supported by Positive Psychology principles.

For AI developers, focusing on learner-centered design and continuous improvement of user experience is crucial for maintaining market share in the competitive AIED market. Developers should prioritize creating tools that enhance learning outcomes and promote positive emotional experiences, in line with Sociocultural Theory and Positive Psychology. By doing so, they can create tools that not only enhance learning outcomes but also promote positive emotional experiences, thereby supporting both cognitive and emotional development.

Despite its notable contributions, the present research is not without limitations. First, owing to limitations in time and resources, the study sampled only from several universities in China. Consequently, the conclusions drawn may be somewhat limited and lack generalizability. Future research will consider expanding the sample size and broadening the sampling scope. Second, in accordance with Sociocultural Theory, social interaction is not limited to peer interactions; teacher-student interactions also warrant exploration for their impact on learners' emotional engagement in AI contexts. Third, the sample exhibited a gender imbalance (73.4% female). While this proportion broadly reflects the demographic patterns observed in Chinese humanities and language education, it nevertheless limits the generalizability of our findings to male EFL learners. Future research should therefore aim for more

balanced samples or explicitly examine gender as a moderating variable to explore potential differences in how male and female learners emotionally engage with AI-assisted language learning. Additionally, the individual characteristics of learners play a significant role in their affective involvement during reading activities. Therefore, in subsequent studies, researchers will further focus on other significant individuals in learners' ZPD and conduct a more comprehensive analysis of the human-related factors influencing learners' engagement in AIED contexts.

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Appendix A. Scales

Construct	Item	Statement
Emotional Engagement	EE1	I looked forward to continuing reading it.
	EE2	I enjoyed learning new things.
	EE3	I felt good.
	EE4	I often felt frustrated.
	EE5	I thought it is boring.
	EE6	I did not care about its content.
Reading Enjoyment	RE1	I got excited about its content.
	RE2	I enjoyed reading it.
	RE3	I started looking forward to going through the text.
	RE4	I was glad that it paid off to read it.
	RE5	My enjoyment of the reading made me proceed.
	RE6	I was so excited saving time on it.
AI Learning Interest	ALI 1	AI courses are interesting to learn.
	ALI 2	Learning about relevant AI knowledge is interesting.
	ALI 3	Learning about AI-related concepts and knowledge is interesting.
	ALI 4	It is interesting to practice the practical AI tasks in the AI-supported course.
	ALI 5	The teacher's guidance and teaching instructions attracted my attention in the AI course.
	ALI 6	For me, AI courses are more interesting than other programming courses.
Learner Interaction	LI1	I interact with other students regarding course content.
	LI2	I get feedback from other students.
	LI3	I communicate with my classmates through AI technologies.
	LI4	Group activities during class help me to interact with my other classmates.
AI Literacy	AIL1	I understand why AI technology requires big data.
	AIL2	I know the processes through which deep learning enables AI to perform voice recognition tasks.
	AIL3	I understand how AI technology optimizes the translation output for online translation.
	AIL4	I know how AI can be used to predict possible outcomes through statistics.
	AIL5	I understand how AI assistants such as SIRI or Hello Google handle human-computer interaction.
	AIL6	I understand how computers process images to produce visual recognition.

Appendix B. Factor Analysis, Convergent Reliability, and Convergent Validity

Constructs	Items	Estimate	S.E.	Z-value	P-value	Factor Loading	α	C.R.	AVE
LI	LI1	1.000				0.826	0.877	0.877	0.641
	LI2	0.927	0.044	21.125	***	0.770			
	LI3	0.928	0.044	21.097	***	0.769			
	LI4	1.021	0.044	23.299	***	0.834			
AIL	AIL1	1.000				0.824	0.918	0.919	0.653
	AIL2	0.959	0.042	22.577	***	0.781			
	AIL3	0.984	0.043	23.068	***	0.793			
	AIL4	1.007	0.041	24.603	***	0.830			
	AIL5	0.956	0.040	23.797	***	0.811			
	AIL6	0.977	0.041	23.669	***	0.808			
ALI	ALI1	1.000				0.884	0.947	0.948	0.751
	ALI2	1.030	0.031	33.650	***	0.899			
	ALI3	0.863	0.029	30.012	***	0.852			
	ALI4	0.970	0.030	32.297	***	0.883			
	ALI5	0.909	0.030	30.688	***	0.862			
	ALI6	0.743	0.027	27.543	***	0.816			
RE	RE1	1.000				0.824	0.928	0.928	0.684
	RE2	0.981	0.038	25.486	***	0.842			
	RE3	1.061	0.040	26.456	***	0.863			
	RE4	0.965	0.041	23.783	***	0.804			
	RE5	0.921	0.038	24.068	***	0.811			
	RE6	0.939	0.039	24.349	***	0.817			
ME	ME1	1.000				0.847	0.939	0.939	0.721
	ME2	1.025	0.036	28.175	***	0.865			
	ME3	0.939	0.036	26.343	***	0.831			
	ME4	1.022	0.037	27.714	***	0.857			
	ME5	0.944	0.035	26.917	***	0.842			
	ME6	0.972	0.035	27.391	***	0.851			

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