Research Article

UNTANGLING THE RELATIONSHIP BETWEEN AI-MEDIATED INFORMAL DIGITAL LEARNING OF ENGLISH, FOREIGN LANGUAGE ENJOYMENT, AND THE IDEAL L2 SELF: EVIDENCE FROM VIETNAMESE UNIVERSITY EFL STUDENTS

Anh Thao Vi Dang, *Thu Nguyen Anh Dong and CaoMinh Man

School of Business, International University, Vietnam National University, Linh Xuan Ward, Ho Chi Minh City, Vietnam.

ABSTRACT

Artificial intelligence–mediated informal digital learning of English (AI-IDLE) has emerged as a prominent form of out-of-class language learning. Despite its growing prevalence, limited empirical attention has been paid to the ways in which motivational self-guides and positive emotional experiences jointly influence learners' engagement in AI-mediated informal learning environments. Grounded in Dörnyei's L2 Motivational Self System and perspectives from Positive Psychology in second language acquisition, this study investigates the predictive roles of the Ideal L2 Self, the Ought-to L2 Self, and Foreign Language Enjoyment (FLE) in shaping Vietnamese university EFL learners' engagement in AI-IDLE. Survey data were obtained from 320 university students and analyzed using Partial Least Squares Structural Equation Modeling. The findings reveal the presence of two complementary motivational pathways. Both the Ideal L2 Self and the Ought-to L2 Self exert significant direct effects on AI-IDLE, while also indirectly influencing engagement through FLE. Notably, the Ideal L2 Self exhibits a stronger relationship with enjoyment, whereas the Ought-to L2 Self demonstrates a comparatively stronger direct association with AI-IDLE. These results extend the applicability of the L2 Motivational Self System to AI-mediated informal learning contexts and highlight enjoyment as a critical affective mechanism that enhances the sustainability and quality of AI-supported English learning beyond the classroom.

Keywords: AI-mediated informal digital learning of English; Foreign Language Enjoyment; Ideal L2 Self; L2 Motivational Self System; Ought-to L2 Self.

INTRODUCTION

Recent developments in artificial intelligence (AI), particularly in generative language technologies, have substantially reshaped opportunities for informal and self-directed English language learning. AI-based applications, including chatbots and intelligent tutoring systems, enable EFL learners to receive instant feedback, engage in simulated interaction, and access personalized learning support beyond formal classroom boundaries. These affordances have contributed to the emergence of AI-mediated informal digital learning of English (AI-IDLE) as a distinctive mode of out-of-class language learning (Chapelle & Sauro, 2017; Huang *et al.,* 2023; Liu *et al.,* 2024).

Parallel to these technological developments, second language acquisition research has increasingly adopted learner-centered perspectives that emphasize motivational self-concepts and emotional experiences as key drivers of sustained engagement. Within this framework, Dörnyei's (2009) L2 Motivational Self System conceptualizes language learning motivation through future-oriented self-guides, namely the Ideal L2 Self and the Ought-to L2 Self, while Positive Psychology in SLA highlights the role of Foreign Language Enjoyment (FLE) in supporting persistence and autonomous learning, particularly in technology-mediated contexts (Dewaele & MacIntyre, 2014; Lee & Lee, 2021).

Although interest in AI-assisted language learning has grown rapidly, empirical studies examining how motivational self-guides and positive emotions jointly shape learners' engagement in AI-IDLE remain scarce. Much of the existing research has focused on learners'

*Corresponding Author: Thu Nguyen Anh Dong,
School of Business, International University, Vietnam National University, Linh Xuan Ward, Ho Chi Minh City, Vietnam.

attitudes toward AI tools or short-term learning outcomes, leaving the underlying psychological mechanisms that sustain informal engagement relatively underexplored. This gap is especially pronounced in the Vietnamese EFL context, where English learning is strongly influenced by certification-oriented goals alongside widespread and frequent use of AI-based learning tools (Liu *et al.,* 2024; Zou *et al.,* 2025).

In response to this gap, the present study examines how the Ideal L2 Self, the Ought-to L2 Self, and FLE jointly predict Vietnamese university EFL learners' engagement in AI-IDLE. Drawing on the L2 Motivational Self System and Positive Psychology in SLA, the study proposes and empirically tests a motivational–emotional–behavioral model in which enjoyment operates as a key affective mechanism linking motivational self-guides to AI-IDLE. By situating AI-IDLE within an integrated psychological framework, this study extends existing motivation theories to AI-mediated informal learning contexts and offers implications for the design of AI-based language learning environments that are both emotionally engaging and motivationally supportive.

LITERATURE REVIEW

Motivation, Emotion, and AI-Mediated Informal Digital Learning of English

Motivation and emotion are central to second and foreign language learning, particularly in informal and autonomous contexts where learners must regulate their own engagement; within this framework, Dörnyei's (2009) L2 Motivational Self System conceptualizes motivation through future-oriented self-guides (Ideal L2 Self and Ought-to L2 Self), while Positive Psychology in SLA emphasizes FLE as a key affective driver of sustained engagement (Dörnyei, 2009; Dewaele & MacIntyre, 2014).

Recent technological developments have expanded informal learning environments through AI-IDLE, which incorporates tools such as chatbots and generative language models to provide personalized feedback, simulated communication, and low-risk practice opportunities (Liu *et al.,* 2024, 2025). These features allow learners to enact future-oriented self-images while simultaneously addressing performance-oriented goals, positioning AI-IDLE as a psychologically structured learning ecology rather than a purely technological phenomenon.

From a motivational–emotional perspective, AI-IDLE enables the enactment of the Ideal L2 Self through simulated communicative practice, while also supporting Ought-to L2 Self–driven goals such as exam preparation and efficiency-oriented learning. Interaction with AI has also been shown to foster enjoyment, which plays a critical role in sustaining engagement and deepening learners' involvement in informal digital learning activities (Lee & Lee, 2021; Zou *et al.,* 2025). Accordingly, AI-IDLE can be conceptualized as an outcome jointly shaped by motivational self-guides and affective experience, with enjoyment functioning as a key mechanism linking motivation to sustained informal engagement.

Hypothesis Development

Drawing on the L2 Motivational Self System and Positive Psychology in SLA, the present study examines how motivational self-guides and enjoyment jointly shape learners' engagement in AI-mediated informal digital learning environments (Dörnyei, 2009; Dewaele & MacIntyre, 2014).

The Ideal L2 Self refers to learners' future-oriented and aspirational self-images as proficient users of the target language (Dörnyei, 2009). When this self-guide is salient, learners are more likely to initiate and sustain autonomous learning behaviors that enable them to approximate their envisioned future identities. AI-mediated informal learning environments are particularly well suited to this process, as tools such as chatbots and generative language models offer simulated interaction, individualized feedback, and low-risk practice opportunities that resonate with learners' imagined communicative selves (Lee & Lee, 2021; Liu *et al.,* 2025).

Prior research has consistently shown that learners with a well-developed Ideal L2 Self tend to engage more actively in informal digital learning activities, including self-directed practice, online interaction, and technology-supported language exploration (Kong *et al.,* 2018; Lee & Drajati, 2019). Within AI-IDLE contexts, such learners may view AI technologies not merely as instrumental aids, but as resources that facilitate the enactment of desired language identities. This perception is likely to enhance both the intensity and persistence of their engagement in AI-mediated informal learning. Accordingly, the present study hypothesizes a positive association between the Ideal L2 Self and AI-IDLE.

H1: The Ideal L2 Self positively predicts AI-IDLE.

Beyond behavioral engagement, the Ideal L2 Self has also been consistently linked to positive emotional experiences in language learning. When learners perceive congruence between their learning activities and their desired future identities, they are more likely to experience enjoyment, pride, and satisfaction (Dewaele & MacIntyre, 2014; Fathi & Mohammaddokht, 2021). Prior studies have demonstrated that learners with a vivid Ideal L2 Self report higher levels of FLE in both classroom-based and informal learning settings (Kong *et al.,* 2018; Liu *et al.,* 2025). In AI-mediated contexts, the flexibility, autonomy, and immediacy afforded by AI tools may further

amplify this positive emotional response. Accordingly, the following hypothesis is proposed:

H2: The Ideal L2 Self positively predicts FLE.

In contrast to the Ideal L2 Self, the Ought-to L2 Self reflects learners' perceived obligations and externally imposed expectations regarding language learning, driven by the desire to avoid negative outcomes or meet external standards (Dörnyei, 2009). Although prevention-oriented, this self-guide can motivate engagement in contexts where academic performance, certification, and career-related goals are emphasized (Yashima *et al.,* 2017). In AI-mediated informal learning environments, obligation-driven motivation may translate into active engagement when AI tools reduce effort costs, provide instant feedback, and support goal-oriented learning (Liu *et al.,* 2024). Accordingly, learners with a salient Ought-to L2 Self are expected to engage more actively in AI-IDLE.

H3: The Ought-to L2 Self positively predicts AI-IDLE.

In contrast, the Ought-to L2 Self reflects motivation driven by perceived external expectations and obligations rather than intrinsic aspirations. Despite its prevention-oriented nature, emerging evidence indicates that obligation-based motivation does not necessarily inhibit positive emotional experiences. In technology-mediated learning environments where activities are perceived as efficient, manageable, and aligned with concrete goals, learners may still experience enjoyment even when initial engagement is externally regulated (Liu *et al.,* 2024; Zou *et al.,* 2025). The structured support and immediacy provided by AI tools may help reframe external pressures as achievable learning demands, thereby fostering more positive affective responses. On this basis, the following hypothesis is proposed.

H4: The Ought-to L2 Self positively predicts FLE.

Foreign Language Enjoyment refers to learners' positive emotional experiences arising from engaging in language learning activities, characterized by feelings of pleasure, interest, and satisfaction **(**Dewaele & MacIntyre, 2014**).** Empirical studies indicate that enjoyment facilitates persistence and depth of participation in digitally mediated learning activities (Dewaele & MacIntyre, 2014; Lee & Lee, 2021).Therefore, the following hypothesis is proposed:

H5: Foreign Language Enjoyment positively predicts AI-IDLE.

Beyond direct effects, motivational self-guides are theorized to influence learning behavior indirectly through affective mechanisms. Prior studies have shown that enjoyment functions as an affective pathway linking motivational self-concepts to autonomous and technology-mediated learning engagement (Fathi & Mohammaddokht, 2021; Liu *et al.,* 2025). On this basis, we hypothesize that:

H6: Foreign Language Enjoyment mediates the relationship between the Ideal L2 Self and AI-IDLE.

H7: Foreign Language Enjoyment mediates the relationship between the Ought-to L2 Self and AI-IDLE.

Based on these hypotheses, a conceptual model is developed in which the Ideal L2 Self and the Ought-to L2 Self are proposed to influence AI-mediated informal digital learning of English both directly and indirectly through FLE (Figure 1).
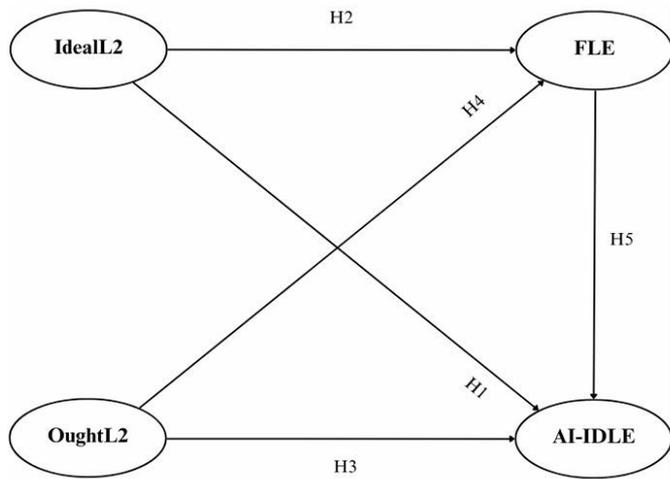
RESEARCH METHODOLOGY

Research Design and Analytical Approach

A quantitative, cross-sectional survey design was adopted to investigate the relationships among the Ideal L2 Self, the Ought-to L2 Self, FLE, and AI-IDLE among Vietnamese university EFL learners. This approach is appropriate for examining theoretically grounded relationships among multiple latent variables within a single data collection period (Paltridge & Phakiti, 2015).

The hypothesized model and its mediating mechanisms were examined using Partial Least Squares Structural Equation Modeling (PLS-SEM) implemented in SmartPLS 4. PLS-SEM is particularly suitable for studies involving latent constructs, mediation analysis, and complex model structures, and has been widely applied in educational and applied linguistics research (Hair *et al.,* 2019).

Instruments

Data were collected using a structured questionnaire adapted from well-established instruments in L2 motivation, positive psychology, and informal digital language learning research. All items were originally developed in English and subsequently translated into Vietnamese to ensure linguistic clarity and contextual appropriateness. Responses were measured on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

The Ideal L2 Self was measured using six items adapted from Dörnyei's (2009) L2 Motivational Self System and the validated scale developed by You *et al.,* (2016), capturing learners' future-oriented self-images as competent English users. A sample item is "I can imagine myself speaking English confidently."

The Ought-to L2 Self was assessed using five items reflecting externally regulated motivation and perceived social obligations toward English learning, adapted from prior L2 motivation research (Dörnyei, 2009; You *et al.,* 2016). A sample item is "I have to study English because people surrounding me expect me to do so."

Foreign Language Enjoyment was measured using five items adapted from established FLE scales (Dewaele & MacIntyre, 2014; Li *et al.,* 2018), with reference to recent applications in technology-mediated learning contexts. A sample item is "Learning English is fun."

AI-mediated informal digital learning of English was operationalized using eight items capturing the frequency and diversity of learners' autonomous, out-of-class English learning activities supported by generative AI tools, informed by prior IDLE and AI-IDLE research (Lee & Drajati, 2019; Lee & Lee, 2021; Liu *et al.,* 2025). A sample item is "I engage in English conversations with AI-powered chatbots to increase my exposure to English."

Participants and Data Collection

Data were gathered through an online questionnaire distributed between September and December 2025. A total of 392 responses were initially collected, of which 320 were retained for analysis after data screening, resulting in a valid response rate of 81.6%.

The final sample consisted of Vietnamese university students aged between 18 and 25 years, including 223 females (69.7%) and 97 males (30.3%). Most participants reported using AI-based tools for English learning on a daily basis, primarily for work-related purposes and preparation for English proficiency examinations such as IELTS and TOEIC. A summary of participants' demographic characteristics is presented in Table 1.

Table 1 Demographics

Demographic	Value	Frequency	Percentage
Gender	Male	97	30.3%
	Female	223	69.7%
	Other	0	0%
Education Level	Freshman	93	29.1%
	Sophomore	11	3.4%
	Senior	187	58.4%
	Junior	28	8.8%
	Other	1	0.3%
University location	Southern region	184	57.5%
	Central region	71	22.2
	Northern region	65	20.3%
English Level	Beginners	134	41.9%
	Basic level	155	48.4%
	Intermediate (communication level)	7	2.2%
	Proficient	24	7.5%
Frequency of AI tools use for English learning	Daily	303	94.7%
	Several times per week	5	1.6%
	Once a week	12	3.8%
	Less than once a week	0	0%
Primary Learning Goal	Improving English communication	7	2.2%
	English proficiency certifications	152	47.5%
	Work-related purpose	161	50.3%
	I do not use an English learning app	0	0%

Source: Authors' own creation using Canva.

Data Analysis Procedure

Data analysis was conducted in accordance with established recommendations for PLS-SEM research (Hair et al., 2019). Prior to model estimation, the dataset was screened to ensure suitability for multivariate analysis. An Exploratory Factor Analysis (EFA) was first

performed using SPSS to examine the underlying factor structure and to guide item retention.

Subsequently, PLS-SEM analysis was carried out using SmartPLS 4. The measurement model was assessed with respect to internal consistency reliability, convergent validity, discriminant validity, and collinearity. The structural model was then evaluated to test the proposed hypotheses. The significance of direct and indirect relationships was examined using a bootstrapping procedure with 5,000 resamples. Model explanatory power and effect sizes were assessed using coefficients of determination (R^2) and f^2 values.

Ethical Considerations

Ethical principles governing social science research were strictly observed. Participation in the study was voluntary, informed consent was obtained electronically prior to data collection, and no personally identifiable information was collected from the participants.

DATA ANALYSIS AND RESULTS

Exploratory Factor Analysis

Prior to conducting the PLS-SEM analysis, an EFA was performed to verify the underlying factor structure of the measurement items. The data were suitable for factor analysis, as evidenced by a Kaiser–Meyer–Olkin (KMO) value above the recommended threshold of 0.60 and a statistically significant Bartlett's test of sphericity ($p < 0.05$) (Table 2).

Factor extraction using principal axis factoring yielded a four-factor solution corresponding to AI-IDLE, Ideal L2 Self, Ought-to L2 Self, and FLE. All retained items demonstrated acceptable factor loadings exceeding 0.50, except for one FLE item (F5), which was excluded due to a marginal loading. The resulting factor structure was theoretically meaningful and accounted for a substantial proportion of the total variance. Detailed EFA results are presented in Table 2.

Table 2 KMO and Bartlett's Test Results

Items	Factor 1	Factor 2	Factor 3	Factor 4
A1	0.903			
A7	0.902			
A6	0.869			
A5	0.852			
A4	0.812			
A2	0.808			
A3	0.753			
A8	0.706			
I6		0.929		
I4		0.809		
I5		0.801		
I3		0.755		
I2		0.718		
I1		0.681		
O3			0.849	
O5			0.806	
O4			0.806	
O2			0.793	
O1			0.713	
F3				0.87
F1				0.628
F2				0.583
F4				0.579

Source: Generated using SmartPLS 4.

Note. Extraction method: Principal Axis Factoring. Rotation method: Promax with Kaiser normalization. Item F5 was excluded due to a marginal factor loading (< 0.50). KMO = 0.966; Bartlett's Test of Sphericity: χ^2 = 6295.147, df = 276, p < 0.001. The final four-factor solution explained 67.87% of the total variance.

Data Screening and Common Method Bias

To examine potential multicollinearity and assess the likelihood of common method bias, variance inflation factor (VIF) values were inspected. All VIF values were below the conservative threshold of 5, suggesting that multicollinearity was not problematic and that common method bias was unlikely to have substantially influenced the results (Table 3).

Table 3 Collinearity (VIF)

	VIF
A1	4.084
A2	3.929
A3	3.822
A4	4.013
A5	4.307
A6	3.746
A7	3.624
A8	3.609
F1	1.812
F2	1.79
F3	2.211
F4	1.82
I1	2.327
I2	2.272
I3	2.528
I4	2.328
I5	2.674
I6	2.381
O1	2.134
O2	2.206
O3	2.543
O4	2.404
O5	2.78

Source: Generated using SmartPLS 4.

Measurement Model Assessment

Convergent Validity and Reliability

The measurement model exhibited satisfactory levels of reliability and convergent validity. Cronbach's alpha, composite reliability (CR), and rho_A values for all constructs exceeded the recommended cutoff of 0.70, indicating adequate internal consistency. In addition, average variance extracted (AVE) values were greater than 0.50, and all indicator loadings met acceptable criteria. Collectively, these results confirm the adequacy of convergent validity and reliability for the measurement model (Table 4).

Table 4 Construct Reliability and Convergent Validity

Factors	Items	Factor loading	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
AI-IDLE	A1	0.900	0.964	0.964	0.97	0.799
	A2	0.895				
	A3	0.894				
	A4	0.899				

	A5	0.906				
	A6	0.890				
	A7	0.883				
	A8	0.887				
FLE	F1	0.815	0.845	0.845	0.896	0.683
	F2	0.812				
	F3	0.863				
	F4	0.814				
Ideal L2 Self	I1	0.836	0.915	0.917	0.934	0.702
	I2	0.824				
	I3	0.849				
	I4	0.830				
	I5	0.862				
	I6	0.826				
Outht-to L2 self	O1	0.830	0.904	0.906	0.928	0.722
	O2	0.823				
	O3	0.864				
	O4	0.855				
	O5	0.875				

Discriminant Validity

Discriminant validity was evaluated using both the heterotrait–monotrait ratio (HTMT) and the Fornell–Larcker criterion. All HTMT values fell below the recommended threshold of 0.85, and the square roots of the AVE values exceeded the corresponding inter-construct correlations, providing evidence of satisfactory discriminant validity (Tables 5 and 6).

Table 5 Discriminant Validity (HTMT)

	A	F	I	O
A				
F	0.808			
I	0.631	0.665		
O	0.614	0.508	0.051	

***Note:** A= AI-Mediated Informal Digital Learning of English, F = Foreign Language Enjoyment, I = Ideal L2 Self, O = Ought-to L2 Self*

Table 6 Discriminant Validity (Fornell–Larcker Criterion)

	A	F	I	O
A	0.894			
F	0.730	0.826		
I	0.594	0.588	0.838	
O	0.576	0.445	0.020	0.850

Model fit was further evaluated using the standardized root mean square residual (SRMR) and the normed fit index (NFI). The SRMR value was below 0.08, and the NFI exceeded 0.90, indicating an acceptable overall model fit (Table 7).

Table 7 Model Fitness

	Saturated Model	Estimated Model
SRMR	0.038	0.038
NFI	0.937	0.937

Structural Model Assessment

Before testing the proposed hypotheses, collinearity among the predictor constructs was examined through inner VIF values. All values were below the threshold of 5, indicating the absence of multicollinearity concerns.

The structural model demonstrated strong explanatory power for both endogenous variables. A substantial proportion of variance was explained in AI-IDLE and FLE. All hypothesized direct paths were statistically significant and in the expected directions, providing support for H1 through H5 (Table 8; Figures 2 and 3).

Mediation effects were assessed using a bootstrapping procedure. The results revealed significant indirect effects of both the Ideal L2 Self and the Ought-to L2 Self on AI-IDLE via Foreign Language Enjoyment, thereby supporting H6 and H7. Because the direct effects remained significant after the inclusion of the mediator, the findings indicate partial mediation (Table 9).

Effect size estimates further showed that the Ideal L2 Self exerted the strongest influence on FLE, whereas the Ought-to L2 Self had comparatively stronger effects on AI-IDLE. Although smaller in magnitude, the effect of Foreign Language Enjoyment on AI-IDLE remained meaningful. A summary of the hypothesis testing results is provided in Table 8, with indirect effects reported in Table 9.

Table 8 Hypotheses testing

Hypothesis	Original Sample (O)	Sample Mean (M)	f²	Standard Deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1: I -> A	0.413	0.413	0.344	0.044	9.480	0.000
H2: I -> F	0.579	0.578	0.717	0.033	17.295	0.000
H3: O -> A	0.437	0.438	0.472	0.035	12.455	0.000
H4: O -> F	0.433	0.434	0.401	0.033	12.962	0.000
H5: F -> A	0.293	0.292	0.139	0.045	6.481	0.000
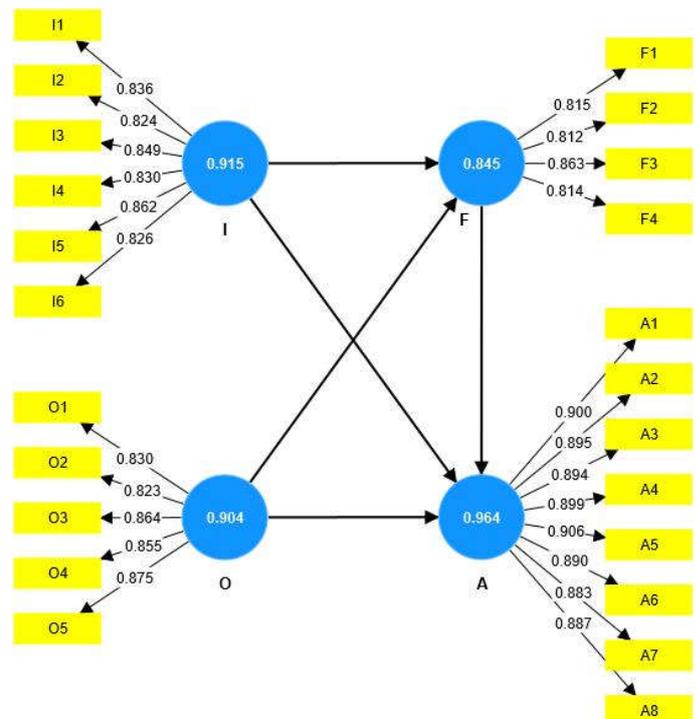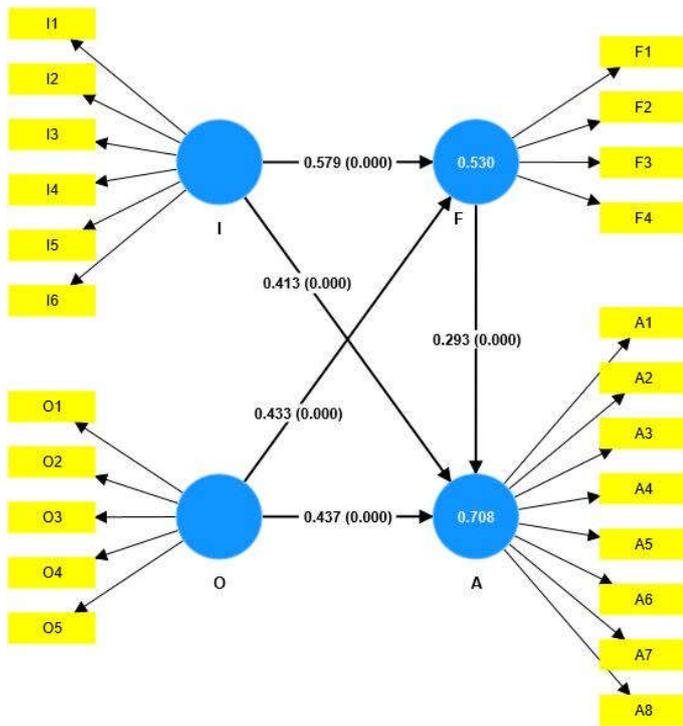
Table 9 Indirect Effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T statistics (|O/STDEV|)	P values
I -> F -> A	0.170	0.169	0.029	5.892	0.000
O -> F -> A	0.127	0.127	0.021	5.941	0.000

DISCUSSION

The present study examined the motivational and emotional mechanisms underlying Vietnamese university EFL learners' engagement in AI-IDLE. Overall, the findings indicate that both motivational self-guides and affective experience play important but functionally distinct roles in shaping learners' AI-IDLE, with FLE operating as a complementary emotional mechanism rather than a sole driver of engagement.

Motivational and Emotional Pathways to AI-IDLE

The results provide empirical support for the proposed motivational–emotional framework linking the Ideal L2 Self, the Ought-to L2 Self, FLE, and AI-IDLE. Even after accounting for motivational self-guides, FLE maintains a significant positive association with AI-IDLE, indicating that enjoyment contributes to sustaining engagement rather than merely initiating AI use. This finding is consistent with recent research distinguishing between superficial or routine technology use and more meaningful forms of informal digital learning (Liu *et al.,* 2024; Zou *et al.,* 2025).

Importantly, the two motivational self-guides operate through different pathways. The Ideal L2 Self demonstrates a stronger relationship with enjoyment, suggesting that aspirational future self-images primarily influence AI-IDLE by fostering positive emotional engagement. In contrast, the Ought-to L2 Self shows a comparatively stronger direct effect on AI-IDLE, implying that obligation-driven motivation can prompt active engagement with AI tools even when positive affect is

less pronounced. The observed pattern of partial mediation further indicates that AI-IDLE can be activated through both affective and non-affective routes, with enjoyment enhancing the quality of engagement rather than fully accounting for motivational effects.

Theoretical Integration

The findings support a dual-pathway interpretation of AI-IDLE. Ideal L2 Self functions primarily as an affective generator, fostering enjoyment and openness toward exploratory learning, whereas Ought-to L2 Self acts as a behavioral activator that promotes engagement through perceived necessity and utility. FLE serves as a bridging mechanism that enhances the quality and sustainability of engagement rather than fully mediating motivational effects.

This pattern extends Dörnyei's L2 Motivational Self System by demonstrating its relevance in AI-mediated informal learning environments. It also aligns with positive psychology perspectives in second language acquisition, which emphasize the role of enjoyment in sustaining long-term engagement. The strong explanatory power of the proposed model reinforces the view that AI-IDLE should be understood as a psychologically structured learning behavior shaped by the interaction of motivation and emotion, rather than as a simple by-product of technological availability (Liu *et al.,* 2024; Zou *et al.,* 2025).

Contextual Interpretation: The Vietnamese EFL Setting

The Vietnamese EFL context offers important insights into the observed relationships. The strong emphasis on work-related outcomes and language certification, combined with widespread daily use of AI tools, creates conditions under which obligation-driven motivation can translate directly into AI-mediated learning engagement (Liu & Ma, 2024; Zhang & Liu, 2025). When AI technologies reduce learning effort and provide immediate feedback, external pressures may become more manageable and actionable rather than emotionally burdensome. This contextual dynamic may help explain why the Ought-to L2 Self predicts both FLE and AI-IDLE in the present sample.

At the same time, the variability observed in AI-IDLE behaviors highlights that learners differ substantially in how they appropriate AI for informal learning purposes. This underscores the importance of moving beyond binary distinctions of AI use versus non-use and instead examining how motivational and emotional conditions shape the quality, intensity, and sustainability of AI-mediated learning engagement.

Limitations and Future Research

Several limitations should be considered when interpreting the findings. First, the cross-sectional research design limits the ability to draw causal conclusions and does not capture the dynamic evolution of motivation, enjoyment, and AI-IDLE over time. Future studies employing longitudinal or experience-sampling methodologies would provide richer insights into these developmental processes. Second, reliance on self-reported data may introduce response biases. Incorporating objective indicators such as learning analytics, task performance measures, or AI usage logs could enhance methodological robustness (Chun *et al.,* 2016; Lee & Drajati, 2019). Third, the use of convenience sampling within a single national context constrains the generalizability of the results. Replication across different educational levels, professional groups, and cultural settings is therefore necessary to assess the broader applicability of the proposed model.

Acknowledgments

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