Effects of AI-assisted Learning on College Students' Flow Experience in English Learning

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Abstract

How AI is applied and how it facilitates flow in second language learning needs more exploration. Based on this, this study examines how AI tool features influence university students' flow in formal English learning and the mediating role of basic psychological needs. A mixed-method design of a survey and semi-structured interviews was adopted on non-English majors with AI learning experience. Results showed that students' flow in English learning was generally above the medium level, with no significant difference between high and low-frequency AI users. AI features are positively correlated with flow. The more students' psychological needs are satisfied, the higher the flow they feel. Group comparison revealed distinct pathways: high-frequency users tend to experience flow directly through tool features, whereas low-frequency users rely more on psychological need satisfaction. Qualitative findings supported these patterns, and also identified barriers that disrupt flow. Moreover, AI's capacity to fulfill relatedness remained limited due to its lack of emotional depth. This study confirms the specific relation between AI features, psychological needs with flow. In addition, it offers both theoretical insights and practical guidance for English learning.

Keywords

AI-assisted learning, flow, English learning, self-determination theory, basic psychological needs

1. Introduction

Artificial intelligence has been integrated into higher education in recent years. Early research indicates that 92% of university students daily use AI devices in 2025 [1]. 86% of students worldwide are using AI in their academic works, and 54% of them use it weekly and 25% daily [2]. As for English learning, AI tools like ChatGPT, Grammarly, and other specialized platforms have especially been applied to the acquisition of language skills with personalized feedbacks and tailored content delivery [3]. To be mentioned, Wu and Wang [4] found that generative AI enhances flow and reduces negative emotions in Chinese university students' informal English learning.

As for second language learning, early research points out the importance of flow. That is flow is a psychological state of absolute absorption and intrinsic enjoyment in task engagement [5]. Previous studies report flow's positive effects on second language learning [6]. For example, Xia and Xu [7] defined flow in the context of Chinese EFL classrooms as "an immersive state characterized by enhanced sense of control

and task value". Flow may reduce negative emotions and promote sustained engagement in academic tasks. Aubrey et al. [8] also report flow's positive effects on motivation, persistence, and learning outcomes.

Studies on second language learning report that academic support, task design adapted to learners' abilities, and self-efficacy can promote flow in classroom context [9,10,11]. Besides, interaction opportunities and clear goals provide direction and motivate engagement, forming the basis for flow [12]. Interaction with others fosters an immersive atmosphere that sharpens focus on language use. In addition, supporting learners' need for competence and relatedness reduces anxiety and increases engagement, thus creating the preconditions for flow.

However, whether AI facilitates flow in second language learning remains unclear. According to Self-Determination Theory (SDT) [13], optimal motivation is based on the satisfaction of three fundamental psychological needs: autonomy, competence, and relatedness. Some studies have confirmed that AI's feedback is accurate and personalized, thus enhancing Chinese college students' positive learning attitudes [14]. Although multimodal teaching has been shown to alleviate cognitive anxiety through enhancing self-efficacy, how its mechanism parallels AI in second language learning remains underexplored. To our knowledge, still no research has systematically investigated how AI's core features, like personalized feedback, interactivity, personalization, satisfy SDT needs to trigger flow in structured classroom settings. In addition, AI tools (e.g., Doubao, DeepSeek) predominantly used by Chinese university students lacks attention. Moreover, classroom environment factors such as student autonomy, teacher feedback, and peer interaction, identified as key predictors of negative emotions in second language learning, have not been integrated into the analysis of AI-assisted learning. How AI is applied and how it facilitates flow in second language learning still needs more exploration.

Based on the case aforementioned, this study examines how AI tool features (feedback quality, interactivity, personalization) relate to flow in Chinese university students' formal English classes, and tests whether Self-Determination Theory (autonomy, competence, relatedness) contribute to flow. To be specific, the following questions are to be answered:

1) What is the relationship between AI tool features (feedback quality, interactivity, personalization) and flow of college students in second language learning with AI tools?

2) Do basic psychological needs (autonomy, competence, relatedness) mediate the relationship between AI features and flow?

2. Method

2.1 Participants

92 participants (42 males, 50 females, Mage=21.04, SDage=7.18) were included in this study. All participants use Chinese as first language and English as second language. All participants take the course for English learning in college years with moderate academic performance. Each participant regularly used at least one AI-assisted English learning tool for 3-4 times per week. The study excluded English majors, individuals with significant language learning difficulties, and those lacking sufficient AI tool experience. All responses were collected anonymously and used solely for academic analysis. Prior to the experiment, all participants provided written informed consent in accordance with institutional and national ethical standards.

2.2 Materials and Procedures

This study used a mixed-method design to collect both quantitative and qualitative data. A questionnaire adapted from Ye's [15] study was used to collect quantitative data. All items used a 5-point Likert scale. Cronbach's α ranged from 0.79 to 0.85, indicating adequate reliability.

Participants were divided into high, and low groups according to their total flow experience score. Semi-structured interviews were conducted to further prove the questionnaire results and understand how AI tool features, basic psychological needs, and flow interact. After considering AI usage time and gender, 6 participants were chosen. Each session was fully recorded and transcribed exactly within 24 hours.

3. Results and Analysis

3.1 Descriptive Analysis

The descriptive statistics of flow are shown in Table 1. In the high-frequency AI-assisted English learning group, the flow of university students was above the medium level (M=3.432, SD=0.834). The flow of the low-frequency use group was also above the medium level (M=3.33, SD=0.842). Overall, the flow experience levels of university students in different AI usage frequency groups were similar, both falling within the above-medium range. This indicates that the learning environment itself can foster a basic level of flow, regardless of how frequently students use AI tools.

Table 1: Descriptive Analysis Results

Group	N	M	SD	SE
High-frequency	55	3.432	0.834	0.118
Low-frequency	37	3.33	0.842	0.14

3.2 Correlation Analysis of the Total Sample (N=92)

Table 2: Correlation Analysis between AI Tool Features and Flow (N=92)

Variable	Statistical Index	AI Tool Features	Flow Experience
AI Tool Features	*Pearson Correlation*	1	0.705**
	Sig. (2-tailed)	—	<.001
Flow Experience	*Pearson Correlation*	0.705**	1
	Sig. (2-tailed)	<.001	—

*Note: ** indicates p<0.001.*

Table 3: Correlation Analysis between Self-Determination Theory (SDT) and Flow (N=92)

Variable	Statistical Index	SDT	Flow Experience
SDT	*Pearson Correlation*	1	0.769**
	Sig. (2-tailed)	—	<.001
Flow Experience	*Pearson Correlation*	0.769**	1
	Sig. (2-tailed)	<.001	—

*Note: ** indicates p<0.001.*

Correlation analysis results between AI tool features, SDT, and flow are shown in Tables 2 and 3, respectively. Both AI tool features and SDT showed a strong, statistically significant positive correlation with flow, and all correlations reaching statistical significance at the 0.01 level (p<0.001).

A strong, statistically significant positive correlation was identified between AI tool features and flow (r=0.705, p<0.01). The core features of AI tools evaluated in this study include feedback quality, interactivity, and the degree of personalized alignment with learning needs. Specifically, higher levels of each of the three features correspond to a more pronounced flow experience among university students in English classrooms.

The strong positive correlation between SDT and flow was even more prominent (r=0.769, p<0.01). This indicates that in AI-assisted learning, the higher the level of satisfaction of students' needs for autonomy, competence, and relatedness, the easier it is for them to enter a flow state.

3.3 Between-Group Analysis

3.3.1 High Frequency Group (N=55)

Table 4: Correlation Analysis between AI Usage Frequency and Flow (N=55)

Variable	Statistical Index	AI Tool Features	Flow Experience
AI Tool Features	*Pearson Correlation*	1	0.710**
	Sig. (2-tailed)	—	<.001
Flow Experience	*Pearson Correlation*	0.710**	1
	Sig. (2-tailed)	<.001	—

Table 5: Correlation Analysis between SDT and Flow (N=55)

Variable	Statistical Index	SDT	Flow Experience
SDT	*Pearson Correlation*	1	0.714**
	Sig. (2-tailed)	—	<.001
Flow Experience	*Pearson Correlation*	0.714**	1
	Sig. (2-tailed)	<.001	—

In the high-frequency group, correlation analysis results between AI tool features, SDT, and flow are shown in Tables 4 and 5. Both AI tool features and SDT showed a strong, statistically significant positive correlation with flow (ps <.001). There is a statistically significant positive correlation between AI tool features and flow (r=0.710, p<.01). It indicates that students who use AI tools frequently have a sharper perception of the tool features, and the correlation between these features and flow is stronger. There is also a statistically significant positive correlation between SDT and flow (r=0.714, p<.01). The results suggest that high-frequency AI use allows students to attain flow more directly via the tool's functional experience, weakening SDT's role as a "mediating bridge".

3.3.2 Low-Frequency Use Group (N=37)

Table 6: Correlation Analysis between AI Tool Features and Flow (N=37)

Variable	Statistical Index	AI Tool Features	Flow Experience
AI Tool Features	*Pearson Correlation*	1	0.698**
	Sig. (2-tailed)	—	<.001
Flow Experience	*Pearson Correlation*	0.698**	1
	Sig. (2-tailed)	<.001	—

Table 7: Correlation Analysis between SDT and Flow (N=37)

Variable	Statistical Index	SDT	Flow Experience
SDT	*Pearson Correlation*	1	0.846**
	Sig. (2-tailed)	—	<.001
Flow Experience	*Pearson Correlation*	0.846**	1
	Sig. (2-tailed)	<.001	—

In the low-frequency group, the results of the correlation analysis between AI tool features, SDT, and flow experience are shown in Tables 6 and 7. The correlations are characterized by a pattern of "weaker correlation with AI tool features, stronger correlation with SDT," and all are statistically significant at the 0.01 level (p<.001).

The correlation between AI tool features and flow is statistically significant positive (r=0.698, p<.01).

There is a statistically significant positive correlation between SDT and flow (r=0.846, p<.01). This finding reveals that when the frequency of AI use is low, the satisfaction of basic psychological needs is the core factor triggering flow, and its predictive effect on flow is more prominent.

3.4 Independent Samples t-test

Table 8: Results of the Independent Samples t-test

	Levene's Test F		T-test						
	F	*p*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*SE Difference*	95% confidence interval	Cohen's d
AI Usage Frequency	0.002	0.964	0.563	84	0.575	0.102	0.181	[-0.258, 0.462]	0.122

An independent samples t-test in Table 8 was conducted to compare the two groups. Levene's test for equality of variances was not significant (F = 0.002, p = 0.964), indicating that the assumption of homogeneity of variance was met. The results showed no statistically significant difference in flow experience between the high-frequency group and the low-frequency group (t (84) = 0.563, p = 0.575).

3.5 Results of Qualitative Analysis

The interviews first confirmed the positive relationship between AI tool features and flow experience, which is consistent with the significant correlation found in the quantitative study (r=0.705, p<0.01). Specifically, multiple participants mentioned a state of "complete concentration and losing track of time",

indicating that certain AI functions can effectively promote immersion in learning. For example, A mentioned that when using English pictures generated by ChatGPT, he was able to "use images to tell stories, increasing the fun" and this multimodal design significantly enhanced concentration; B expressed that during voice conversations with Doubao, due to its natural tone, she "really likes this feature" and was able to be "completely focused". However, flow experience is easily interrupted by technical delays. As C pointed out that "waiting for the response during a voice conversation disrupts my train of thought", indicating that interaction fluency is a key prerequisite for maintaining flow.

Second, AI's personalization features significantly enhanced learners' sense of autonomy and competence, thereby promoting flow, providing evidence for the mediating role of SDT in AI-assisted learning scenarios. C mentioned that after telling Doubao he was a freshman "it gives me suitable vocabulary content. This kind of personalization makes me more willing to actively engage in learning"; A also noted that "I can use commands to get AI to adjust to my learning pace and plan" and this flexibility made her feel "in control of learning". Regarding competence, several mentioned AI's text parsing function reduced task difficulty. C said that when AI parsed complex sentences, "sentences I originally found difficult become simple and easy to understand, making me feel I can learn English well". These findings echo the strong correlation between SDT and flow (r=0.769, p<.01) in the quantitative study, indicating that the satisfaction of psychological needs is an important way to flow.

Notably, different usage frequency groups also showed variation in their perception of AI functions. High-frequency user B had a keener perception of AI functions and could directly experience flow through tool features. Whereas low-frequency user D had more concerns about AI's feedback accuracy and emotional depth, and their flow experience depended more on the satisfaction of psychological needs. This difference aligns with the finding from the group comparison that "the correlation between AI features and flow was stronger in the high-frequency group, while the correlation between SDT and flow was stronger in the low-frequency group".

Furthermore, the satisfaction of relatedness is relatively limited. Because AI's anthropomorphic interaction met learners' need for relatedness to some extent, but its emotional depth still cannot replace real human interaction. C mentioned that Doubao "speaks with intonation", making him feel accompanied, "but in terms of topic continuation, it's not as comfortable as communicating with real people". D pointed out that AI "can never, like a human, be so sensitive to things like emotions". This suggests that AI can simulate human communication superficially, providing learners with a basic sense of companionship. However, it struggles to achieve the emotional resonance found in real human interaction. Consequently, its capacity to fulfill relatedness remains limited.

Participants also generally expressed concern about AI's information accuracy, which to some extent triggered learning anxiety. C pointed out that "different AI software gives different answers to the same question". A worried about "difficulty distinguishing incorrect information," and B admitted, "I don't trust it much. I'm quite anxious". This persistent concern about feedback accuracy weakens the development of competence, suggesting that AI tools need enhancement in information reliability and consistency.

4. Discussion

Based on qualitative and quantitative data, this study mainly has the following findings: the advantages of AI tools and the satisfaction of students' psychological needs jointly enhance flow experience, while tool flaws and psychological anxiety significantly hinder the generation of flow. Additionally, AI's impact on flow is primarily positive and secondarily negative. The positive effect manifests in two aspects. First, through functions like real-time feedback, it directly creates a learning environment conducive to flow. Second, through functional design that satisfies the sense of autonomy and competence, it indirectly stimulates intrinsic motivation. This is the main reason why flow levels of students in both high and low-frequency groups were above average. The negative effect mainly stems from tool design flaws, such as inaccurate feedback or delays, which weaken students' sense of autonomy and competence and indirectly hinder flow. However, these problems are not inevitable. By optimizing algorithms and increasing adaptability, negative impacts can be effectively reduced.

4.1   Key Factors Promoting / Hindering Flow Experience

The generation of flow experience primarily relies on the combined push from two aspects: the advantages of AI tools themselves and the satisfaction of students' psychological needs, both of which are significantly positively correlated with flow.

At the tool level, real-time feedback, good interactivity, and personalized recommendations are direct triggers of flow. Data show that the correlation coefficient between AI tool features and flow in the total sample was 0.705, and it was higher (0.710) among high-frequency users, indicating they are more sensitive to the tool. In interviews, students mentioned that AI's instant correction allows them to correct mistakes quickly without interrupting their thought; voice conversation creates a sense of communication; and personalized content can match their level, avoiding excessive difficulty or ease, all of which make it easier for them to enter a state of focus.

At the psychological level, the satisfaction of the sense of autonomy and competence is the core foundation of flow, while the role of relatedness is limited. AI allows students to choose learning content and pace themselves, satisfying autonomy; by parsing complex sentences and analyzing materials to reduce learning difficulty, it enables students to feel a sense of achievement, satisfying competence. Although AI's anthropomorphic interaction can alleviate loneliness to some extent, it cannot replace real human communication, so the role of relatedness is relatively small.

It is worth noting that the core facilitating factors differ between the two student groups: high-frequency users place greater importance on the tool's functions themselves, while low-frequency users rely more on the satisfaction of psychological needs, which is highly consistent with the quantitative results.

While tool flaws and psychological anxiety are common obstacles across both high and low-frequency user groups, their primary effect is to disrupt the continuity of flow rather than affect its overall level. First, technical problems disrupt focus. Tool flaws like response delays or a failure to understand the student's needs can break the learning rhythm. This interruption breaks the learning rhythm and makes it difficult to maintain flow. Second, inaccurate AI feedback causes anxiety. When different AI systems give inconsistent or incorrect answers to the same question, students lose trust in the tool. This can lead to a diminished sense of achievement and competence, ultimately hindering the emergence of flow. Additionally, low-frequency users have low trust in AI, viewing it merely as a tool to complete assignments, and are unwilling to engage deeply, which also makes it difficult for them to enter a state of deep focus.

4.2   The Predictive Power of AI Features and SDT Needs for Flow

Both AI features and SDT needs can positively predict flow. In the total sample, the predictive power of SDT was significantly higher than that of AI tool features, indicating that SDT's predictive power is stronger, and flow is inherently driven by intrinsic psychological motivation.

Among the three dimensions of SDT, the sense of autonomy and competence are fundamental. AI's personalized design enables students to control the learning process, satisfying autonomy; immediate assistance and difficulty adaptation enable students to feel a sense of achievement, satisfying competence; these two are the core of predicting flow. The role of relatedness is weaker because students consistently view AI merely as a tool, and human-computer interaction can't replace real communication with teachers and peers.

Notably, the way AI features influence flow primarily depends on the student's usage frequency. For high-frequency users, AI features have a direct impact on flow. Students have become proficient in using the tool and integrated it into their learning habits. Factors like tool fluency and feedback speed maintain focus, without needing to rely on the mediation of psychological needs. For low-frequency users, AI features have an indirect impact on flow through the mediation of SDT needs. For students unaccustomed to the tool, flow occurs only when AI satisfies their sense of autonomy and competence; here, the satisfaction of psychological needs is the key.

5. Conclusion

This study investigated the state of psychological flow among non-English major university students in AI-assisted English learning. The results showed that the flow of this group was generally above the medium level. The functions of real-time feedback and personalized recommendations in AI tools can effectively satisfy students' sense of autonomy and competence during learning, thereby significantly promoting the generation of flow experience. While the stability of AI responses and the adaptability of functions to learning tasks are key factors affecting the quality of the flow. Simultaneously, the frequency of AI use affects how these factors take effect. High-frequency users acquire flow more easily due to the functional characteristics of the tool itself, while low-frequency users rely more on the satisfaction of psychological needs to trigger flow.

This study holds certain theoretical and practical significance. Theoretically, it confirms the applicability of Self-Determination Theory within AI-assisted English learning, providing empirical support for its use in intelligent learning contexts. Practically, the findings inform the optimization of English learning features in AI tools and can provide a reference for universities in developing AI-integrated English teaching strategies. Both applications aim to enhance students' flow during English learning.

There are still some limitations in this study. It only conducted a cross-sectional investigation and didn't track the long-term changes in students' flow. Future research could conduct longitudinal studies to continuously follow the developmental patterns. Furthermore, the scope of research participants was not broad enough, and the sample range can be expanded in subsequent studies.

References

[1] Freeman, J. Student Generative AI Survey 2025[R]. Higher Education Policy Institute (HEPI), 2025.

[2] Digital Education Council. (2024). Survey: 86% of students already use AI in their studies.

[3] Xiao, Y. (2025). The impact of AI-driven speech recognition on EFL listening comprehension, flow experience, and anxiety: A randomized controlled trial. Humanities and Social Sciences Communications, 12, 35.

[4] Wu, H., & Wang, Y. (2025). Disclosing Chinese college students' flow experience in GenAI-assisted informal digital learning of English: A self-determination theory perspective. Learning and Motivation, 90, 102134.

[5] Csikszentmihalyi, M. (1990). Flow: The psychology of optimal experience. New York: Harper & Row.

[6] Bodea, A., & Trofimovich, P. (2024). Transported into like another space: Second language learners' perspectives on their experience of flow. The Language Learning Journal, 52(6), 710–722.

[7] Xia, Y., & Xu, Y. (2018). A Study on the Influence of Classroom Environmental Factors on Students' Negative Academic Emotions Among English Majors. Foreign Languages and Their Teaching, (03), 65-76, 144-145. (in Chinese).

[8] Aubrey, S., Zhang, L., & Zhou, M. R. (2025). Flow in language learning: A systematic review of methodological features. Language Teaching Research. Advance online publication.

[9] Hu, J., & Zhu, Y. (2025). Effects of Students' Perceived Teacher Support on Their Foreign Language Enjoyment: A Self-Determination Theory Perspective. Foreign Languages and Their Teaching, (01), 75-83, 147-148. (in Chinese).

[10] Li, C. C., & Dewaele, J.-M. (2020). The Predictive Effects of Trait Emotional Intelligence and Online Learning Achievement Perceptions on Foreign Language Class Boredom Among Chinese University Students? Foreign Languages and Their Teaching, (05), 33-44, 148-149. (in Chinese).

[11] Hu, J., & Ni, K. (2024). Research on Foreign Language Learning Anxiety of Non-English Major Students from a Multimodal Perspective. Journal of Harbin University, 45(12), 113-117 (in Chinese).

[12] Egbert, J. (2003). A study of flow theory in the foreign language classroom. The Modern Language Journal, 87(4), 499-518.

[13] Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. Contemporary Educational Psychology, 61, 101860.

[14] Wang, Y., Wu, H., Derakhshan, A., & Wang, Y. (2024). Developing and Validating the Psychometric Properties of the GenAI-Assisted EFL Learning Inventory in the Context of Chinese Universities. Journal of Beijing International Studies University, 46(06), 30-45 (in Chinese).

[15] Ye, J. H. (2013). Study on Learning Flow of the Adolescent (Doctoral dissertation). Jiangxi Normal University. (in Chinese).

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Conflicts of Interest

The authors declare no conflict of interest.

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