

Exploring College Students' AI-Supported Flow during Language Learning Tasks in Virtual Environments

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How to cite: Borysenko, N. (2026). Exploring college students' AI-supported flow during language learning tasks in virtual environments. In: 12th International Conference on Higher Education Advances (HEAd'26). Valencia, 15-18 June 2026. <https://doi.org/10.4995/HEAd26.2026.21636>

Abstract

This exploratory qualitative study investigates how artificial intelligence (AI) supports flow experiences in English language learning within a virtual environment (VE). Ten college-level English language learners (ELLs) completed a content-based task in a Minecraft prebuilt world (Isles of Mythology), supported by ChatGPT for navigation, vocabulary, and comprehension. Data from background interviews, observations, screencasts, structured task-content questionnaires, a Flow survey, and follow-up interviews were analyzed qualitatively. Most participants reported experiencing flow, characterized by focused attention, perceived challenge–skill balance, task authenticity, and a sense of learner control. AI support was perceived as reducing anxiety, supporting comprehension, and enabling both compensatory and extended engagement during task completion. The findings suggest that AI-supported VEs may foster adaptive and inclusive engagement in language learning tasks, highlighting the importance of pedagogically informed task design and intentional AI integration.

Keywords: language learning; flow; AI; ChatGPT; virtual environments; Minecraft.

1. Introduction

Student engagement is a critical factor in English language learners' (ELLs') academic achievement; however, traditional teaching approaches do not always engage ELLs consistently, which may limit learning outcomes. In response, the integration of technology, particularly virtual environments (VEs) and artificial intelligence (AI), has shown promise in increasing engagement and facilitating personalized learning (Al Nabhani et al., 2025; Kohnke et al., 2025). AI software, including adaptive learning platforms and intelligent tutoring systems, can dynamically tailor content, provide instant feedback, and analyze learners' interactions to optimize challenge–skill balance, thus supporting Flow Theory principles (Csikszentmihályi,

2000). This study investigates the intersection of AI-supported VEs and Flow Theory, exploring how such digital tools may engage ELLs in meaningful language learning tasks.

2. Flow Theory and AI-Supported Language Learning in Virtual Environments

Flow Theory describes a state of optimal experience in which learners are fully immersed in a task, experiencing deep focus and a balance between challenge and skills (Csikszentmihályi, 2014). This state aligns with behavioral, cognitive, and emotional engagement, which are strongly linked to student achievement (Al-Obaydi et al., 2023). Flow occurs when learners' perceived skills match task demands, particularly when both are high, while mismatches may result in boredom or anxiety (Csikszentmihályi, 2014). Key conditions supporting flow include clear goals, immediate feedback, focused attention, a sense of control, and altered time perception. In education, flow is most likely to emerge when learners face progressively challenging tasks while developing corresponding skills. Learner characteristics such as curiosity and perseverance further enhance flow experiences (Hamari & Koivisto, 2014).

Although flow remains relatively underexplored in language learning, research suggests its importance for ELL engagement. Egbert (2003) identified essential flow conditions in language tasks, including challenge–skill balance, focused attention, task authenticity, and learner control. Later studies show that flow supports persistence, motivation, and improved learning outcomes (Amini et al., 2016; Aubrey, 2017). Thus, learning environments that embed these conditions are particularly valuable for language instruction. Virtual environments, interactive 3D spaces where learners can explore, create, and collaborate (Schroeder, 2008), exemplify such contexts. *Minecraft*, a widely used sandbox VE, aligns closely with essential flow principles by offering immersive settings, adjustable challenges, autonomy, and problem-solving opportunities (Alawagee & Delafield-Butt, 2021), facilitating participatory and exploratory learning through multiple interaction pathways (Rodríguez-Ardura & Meseguer-Artola, 2017).

AI integration further enhances VEs' potential to support flow by providing adaptive scaffolding, real-time feedback, and personalized guidance, helping learners maintain a balance between challenges and skills. In AI-supported *Minecraft* tasks, learners may receive contextual hints, language prompts, or navigation support, maintaining engagement and task control. Research shows that AI-supported educational tools can boost motivation and engagement through personalized learning pathways and adaptive feedback (Chen et al., 2022; Holmes et al., 2019; Tan et al., 2025). Yet, how AI optimizes ELLs' flow states in VE-based language tasks remains underexplored.

3. Methodology

This exploratory qualitative study involved ten college-level ELLs with varying experience in *Minecraft* and basic proficiency in AI tools, including *ChatGPT*. The study took place in a college computer laboratory using the multi-user mode of *Minecraft* to support interaction and collaboration.

Participants navigated a prebuilt *Minecraft* world, *Isles of Mythology*, selected for its visually rich, content-based environment presenting English-language texts on ancient myths. The world featured multiple information stands (I-stands) describing myths from ancient civilizations, providing content- and language-integrated learning opportunities that supported task authenticity, focused attention, and purposeful engagement (Davies, 2017). These design features required only basic navigation and language skills, helping minimize cognitive overload and allowing learners to focus on task-related language use and interaction.

To further support engagement, participants accessed *ChatGPT* on personal laptops alongside *Minecraft*. AI support provided on-demand explanations, vocabulary clarification, and task guidance, facilitating comprehension, reducing anxiety, and supporting challenge–skill balance during task completion. Together, the immersive affordances of the VE and adaptive AI scaffolding offered complementary forms of support that helped participants regulate task demands while maintaining engagement, consistent with prior research on AI-assisted learning and flow experiences (Holmes et al., 2019; Zhai et al., 2024).

The study began with a 50-minute training session on VE controls and avatar navigation. Participants were seated in a U-shaped layout in a college computer lab and were provided with handouts detailing *Minecraft* controls, login procedures, and avatar operation. After training, they completed Can-Do checklists to confirm navigation readiness. The researcher then introduced the task both orally and in writing. During the 50-minute task, participants individually explored the VE, located I-stands, opened and read mythology texts, and took notes if desired. Interaction occurred through *Minecraft* text chat, supporting collaborative problem-solving while preserving written records for analysis. *ChatGPT* served as an additional resource to clarify instructions or content, supporting task control and engagement. As the final stage of the task, participants completed a structured task-content questionnaire, followed by a Flow survey.

Data sources included background interviews, observations, screencasts, a structured task-content questionnaire, a Flow survey, and follow-up interviews. Qualitative data from interviews, the questionnaire, and open-ended survey responses were coded using four flow dimensions—challenge–skill balance, focused attention, task authenticity, and learner control—while additional themes, including risk-taking, competitiveness, and face-saving behaviors, emerged inductively. Observational and screencast data were analyzed for behavioral indicators of engagement and attention, and descriptive analysis of AI-assisted

interactions provided further evidence of task control and skill development. Findings were synthesized across data sources to examine how AI-supported interaction within the virtual environment related to learners' flow experiences.

Data were analyzed using thematic analysis (Braun & Clarke, 2021), informed by Flow Theory as a sensitizing analytical framework (Csikszentmihályi, 2014). An initial deductive coding phase applied the four essential flow conditions—challenge–skill balance, focused attention, task authenticity, and learner control—to interview transcripts, open-ended questionnaire responses, and observational notes. A subsequent inductive phase allowed additional themes to emerge from the data, including risk-taking, face-saving behaviors, competitiveness, and strategic AI use. Screencasts and chat logs were analyzed for behavioral indicators of engagement and task control, triangulating self-reported perceptions with observed interaction patterns. Numerical summaries of Flow survey responses were used descriptively and solely to contextualize qualitative interpretations, consistent with exploratory qualitative research practices.

4. Findings and Discussion

In line with the exploratory qualitative design, findings are presented alongside interpretive discussion to illustrate patterns of learner engagement within the AI-supported VE. Given the small sample size and descriptive analytical orientation, the findings are not presented as generalizable outcomes but as indicative patterns exemplifying how task design, VE affordances, and AI scaffolding jointly shaped learners' engagement and perceived flow. This analytic approach reflects prior computer-assisted language learning (CALL) research showing that learner engagement in VEs depends on intentional task design rather than on VE affordances alone (Egbert & Borysenko, 2018).

Across participants, alignment between task demands and learners' navigational and linguistic skills emerged as a foundational condition for flow (see Table 1). Participants who demonstrated purposeful navigation and continuous interaction with the VE reported higher levels of focused attention and perceived control, whereas those distracted by physical discomfort or specific *Minecraft* features exhibited weaker flow experiences. These observations align with Flow Theory, particularly the role of challenge–skill balance and focused attention. However, in AI-supported virtual contexts, these conditions were not regulated by the learner alone. Task challenge, feedback, and pacing were partially mediated through AI interactions, suggesting that responsibility for controlling the task was shared between learners and the AI.

Learner control was frequently enacted through strategic AI use. ELLs described relying on *ChatGPT* to clarify vocabulary, confirm comprehension, or guide navigation in the VE without interrupting task engagement. Rather than limiting learner control, this use of AI often helped

maintain involvement by preventing misunderstandings that might otherwise disrupt flow. This suggests that in AI-supported virtual environments, flow may function as a relational state emerging from interactions among the learner, the task, the VE, and AI scaffolds, complicating traditional conceptions of flow as an exclusively internal psychological experience.

Table 1. Exploratory Profiles of Flow Experiences and AI-Supported Engagement Across Participants

Participant	Mean Flow	Interest	Challenge-Skill Balance	Attention	Control	AI Use	Overall
P1	4.7	4.8	4.8	4.5	4.9	Vocabulary clarification, examples	Strong desire to return
P2	4.5	4.4	4.8	4.3	4.6	Checking mythological terms	Positive, wants more competition
P3	4.2	4.6	3.7	5.0	3.4	Vocabulary/paraphrasing	Positive, AI-compensated difficulties
P4	3.4	2.4	3.8	3.5	4.1	Minimal use, peer collaboration	Negative, would not return
P5	4.6	4.7	4.5	4.6	4.8	Comprehension checks	Highly motivated to return
P6	4.9	5.0	4.9	4.8	5.0	Comparing myths, extending content	Very strong desire to repeat
P7	4.5	4.5	4.2	4.5	4.7	Vocabulary clarification	Positive, reduced
P8	4.8	4.9	4.7	4.8	4.9	AI-generated comprehension tests	Very positive, "teacher-like presence"
P9	4.3	4.2	4.0	4.1	4.5	Translations, vocabulary	Moderate, but values support
P10	5.0	5.0	5.0	5.0	5.0	Paraphrasing	Absolute flow, wants testing

Note. Flow ratings are reported descriptively to contextualize an exploratory qualitative analysis; qualitative summaries reflect ELLs' subjective perceptions and are not intended for statistical comparison.

Consistent patterns across collected data indicate that AI functioned both as a compensatory scaffold and as a stimulus for deeper engagement. For learners facing linguistic or navigational challenges, AI support was perceived as reducing anxiety and preserving challenge–skill balance, thereby preventing disengagement. For more proficient learners, AI enabled extensions beyond task requirements, including cross-textual comparisons and deeper content explanation.

This dual function highlights AI's capacity to accommodate diverse ELLs' needs within a shared task context while avoiding one-size-fits-all learning pathways.

Alongside these benefits, the findings also raise questions about learner control and over-reliance on AI. Although participants often described AI as a helpful, "teacher-like" presence, AI use sometimes shifted their focus toward efficient task completion rather than deeper engagement with language. In these cases, AI use could reduce opportunities for independent thinking and learning through challenge, both of which are crucial for language development. These tensions reflect wider concerns about dependence on AI and changes in learner control in technology-supported learning environments.

Patterns of attention and control further show these dynamics. Learners who experienced flow typically combined focused navigation with purposeful use of AI. This suggests that learner control was not lost but instead adjusted through interaction with AI. However, maintaining this balance depended on task design and individual differences among ELLs. When AI use was unguided or excessive, it could shift from a supportive scaffold to a shortcut for completing tasks, changing how learners engaged with the task. These findings indicate the need for careful use of AI in education, ensuring that AI supports learning while preserving learner autonomy.

Participants' expressed interest in competitive and socially embedded elements points to an additional condition of task engagement not fully captured by the outlined flow framework. While AI-supported, VE-based language tasks maintained engagement for most ELLs, integrating collaborative and competitive activities may further intensify learners' involvement and deepen their flow experiences. This suggests that future AI-supported, VE-based language tasks should consider not only individual learner control but also socially mediated forms of engagement.

Overall, the findings indicate that AI-supported virtual environments can mediate essential flow conditions—challenge–skill balance, focused attention, task authenticity, and perceived control—while simultaneously reshaping how these conditions are enacted. By embedding adaptive scaffolds within immersive language tasks, such environments show promise for maintaining engagement among diverse ELLs. The study underscores the need to critically examine how AI may transform task guidance processes, learner control, and the nature of flow itself in technology-supported language learning contexts.

Despite providing in-depth insights into AI-supported flow experiences in a VE-based language task, this study has several qualitative limitations. The small number of participants constrains the transferability of the findings beyond the specific research context. However, the participant group reflects a typical instructional group size in foreign-language learning settings, enabling close observation of learner interaction, task engagement, and AI use. Designed as an exploratory qualitative inquiry, the study aimed to develop context-sensitive understandings and identify salient engagement patterns, rather than produce generalizable or predictive claims.

Thus, the findings support analytic rather than statistical generalization and should be interpreted as illustrative of situated learner experiences within this task setting.

In addition, the absence of contrasting task conditions (e.g., tasks without AI support or conducted outside a virtual environment) limits how specific design features can be interpreted as shaping participants' flow experiences. ELLs' engagement is therefore best understood as emerging from the interrelated influence of task design, VE affordances, and AI scaffolding. Although reliance on self-reported accounts may introduce subjectivity, triangulation across interviews, observations, screencasts, a structured task-content questionnaire, and a Flow survey strengthened the credibility of the findings.

5. Conclusions

This study examined how ELLs experienced flow during an AI-supported, content-based task in a virtual environment. The findings indicate that flow did not emerge as a uniform outcome but as a situated experience shaped by task design, VE features, individual learner differences, and AI support. Rather than functioning independently, AI operated as part of the broader learning context, sharing responsibility for supporting engagement and task control.

AI support played a key role in helping learners manage linguistic and navigational demands. For some participants, adaptive scaffolding reduced anxiety and helped maintain an appropriate balance between challenge and skill, supporting maintained engagement. For others, AI enabled deeper exploration beyond task requirements. At the same time, the findings point to important challenges. Specifically, unguided or excessive AI use sometimes shifted attention toward task efficiency rather than meaningful language engagement, emphasizing the need to support challenge without reducing learner control.

As an exploratory qualitative inquiry situated within a specific instructional context, the findings are not intended for broad transfer beyond the study setting. Instead, they offer conceptual and pedagogical insights into how AI-supported VEs can foster adaptive and inclusive engagement in language learning. Future research may build on these insights by exploring varied task designs, extended use over time, and socially embedded interaction to deepen understanding of how AI-supported VEs shape flow experiences and ELLs' control over learning across educational contexts.

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Article in Press