Language Urban Odyssey: A Serious Game for Enhancing Second Language Acquisition through Large Language Models

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ABSTRACT

Traditional second language acquisition (SLA) often lacks deep immersion in authentic environments, presenting high learning and resource challenges. To overcome this, we introduced "Language Urban Odyssey" (LUO), a serious game designed to offer an affordable language practice environment. LUO combines Large Language Models (LLMs) with game-based learning, creating an immersive and interactive experience. Players interact with AI-driven characters in a fictional city, leveraging ChatGPT 3.5's capabilities for simulating real language use and cultural diversity. The game aims to reduce language learning barriers, ignite interest, and provide practical scenarios. Test results show LUO significantly boosts interest and proficiency in language learning. Players praise its engaging narrative, interactive dialogues, and adaptive experience. However, while LUO is beneficial, it's crucial to recognize gamified learning's limits; genuine language fluency still requires real-life communication practice and validation.

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CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools**; • **Applied computing** → **Interactive learning environments**.

KEYWORDS

Educational Games, Second Language Acquisition, Human-AI Interaction, Large Language Models

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1 INTRODUCTION

In Second Language Acquisition (SLA), learners often struggle to reach proficiency in a second language, especially in non-native environments. This issue, often leading to 'Fossilization', hampers language progress [7]. Enhancing real-world communication and encouraging use in authentic contexts can alleviate this. For Chinese learners, practical English usage opportunities within Chinese contexts are scarce. Accessing an English-speaking environment typically demands significant resources [10], leading to reduced motivation and interest, impairing learning abilities [26]. Addressing this, we developed 'Language Urban Odyssey' (LUO), a serious game for cost-effective second language learning. LUO integrates gamified learning with Large Language Model (LLM) technologies, providing an interactive platform for language practice. It replicates a real-life second-language environment in a game setting, boosting engagement and effective language practice.

2 RELATED WORKS

2.1 Second Language Acquisition in HCI

Human-Computer Interaction (HCI) has consistently emphasized education [6], particularly second language acquisition, due to its role in international exchanges and global classroom dynamics. Learners often find mastering a second language difficult, citing challenges and stress, especially in applying skills like speaking, writing, reading, and listening in real-life contexts. This may leads to Second Language Learning Fossilization [3]. HCI researchers have explored solutions to this issue. Song's study on AI and second language learner dialogues indicates positive impacts on language learning but highlights the need for a solid language foundation and the significant costs involved [20]. Meunier observe that advancements in AI and HCI, especially with Large Language Models (LLMs), are revolutionizing language acquisition and usage by providing versatile learning resources [16]. Boudadi found that gamified language learning boosts engagement but complex systems may impede learning [2]. Studies by Loewen on apps like Duolingo show that translating app-based learning into real-life language use is challenging for learners, often leading to decreased interest [14]. The current gamification in second language education struggles to replicate the dynamic and varied real-world language scenarios. Rigid in-game dialogues result in low efficiency and diminishing learner interest. While mature LLMs address the issue of real-time, varied dialogues, integrating these models with gamified designs in language education poses a significant challenge, underscoring the need for innovative solutions in this field.

2.2 Applications of Large Language Models in Education

Large Language Models (LLMs) like GPT-3 are revolutionizing education, applied in creating content, enhancing engagement, and personalizing learning experiences [12]. Research by Benjamin et al. has demonstrated that LLMs can detect misunderstandings, perform language translation, and generate content in intelligent tutoring systems, but also highlighted the significance of real-time interaction and comprehensive data training [17]. Through a four-week comparative study, Wang et al. substantiated that ChatGPT could significantly improve English reading comprehension and interest among Chinese university students [25]. These studies validate the feasibility of using LLMs to assist in language learning and error correction. The application of LLMs in language education extends beyond error detection and correction; they can also create personalized educational content and lower the barriers to learning, although attention to dataset training is necessary.

2.3 Current Serious Games for Education

Serious games integrate educational content with interactive elements, promoting learning through gameplay in fields like health, management, and disaster prevention [4, 15, 19, 23]. These games prioritize educational objectives over entertainment, yet their dependence on self-directed learning may reduce engagement [9]. Enhancements in problem-based learning and narrative design are recommended to improve immersion and educational effectiveness [13]. Research by Ferguson, van den Broek, and van Oostendorp highlights the trade-off between cognitive engagement and learning focus in game navigation [8]. Our design strategy centers on narrative-driven and immersive elements to foster language acquisition, with a balance between engaging content and educational goals. Additionally, leveraging LLMs for creating RPG dialogues has shown promise in enhancing narrative depth and interactivity in games, as evidenced by the application of GPT-2 and knowledge graph-integrated frameworks [1, 24]. Utilizing LLMs for crafting personalized content in language learning games could significantly aid second language acquisition.

3 GAME DESIGN

"Language Urban Odyssey" (LUO), a serious game for language education, merges AI large language model capabilities with language learning needs, providing immersive experiences in "Cosmopolis." Players, as "Alex," tackle professional tasks to gain prominence. The game's core, integrating ChatGPT in NPC dialogues, offers realistic multilingual interactions. Our design theme, rules, and game elements aim to mitigate three potential barriers in the language learning process: high entry thresholds, low interest, and insufficient real-world practice. To address these factors, we established the following design rules:

- **Easy to learn**: Players can start language learning without complex preparatory steps, and those unfamiliar with gaming can play effortlessly.
- **Willingness to learn**: By utilizing a gaming format to assist language learning, we enhance players' interest in engaging in language practice, thereby improving language application and comprehension during gameplay.
- **Practicality**: By creating scenarios that mirror everyday conversations and providing immediate dialogue feedback, we offer players the opportunity to learn different languages and cultures, helping them experience and master practical language skills during gameplay.

3.1 Lowering the Barriers to Understanding and Language Learning

LUO aims to simplify language learning via gaming, eschewing complexity often associated with game formats. We crafted game elements, interaction logic, and format for simplicity and ease of understanding, ensuring accessibility for gaming novices and facilitating language acquisition.

3.1.1 Themes and Game Elements. LUO's artistic design prioritizes simplicity and clarity, particularly in game environments and NPC creation. The stylized design of game environments effectively conveys each scene's theme; similarly, as representative game elements, unique NPC appearances and interaction styles enhance player engagement. The following sections provide a detailed introduction to the game environments and NPC design (Fig2.a).

- **Game Environments**: Employing pixel art and cartoonish design, the game offers a relaxed visual experience. This style simplifies game elements, helping alleviate the stress players might feel from the game outside of language learning. We emphasize the theme of each game environment with pixelated elements, aiding players in better immersing themselves in the game's communication settings.

- **NPC Design**: Our game's NPCs feature unique appearances and speech patterns, enabling players to deduce their roles and traits for immersive role-playing by observing their appearance. Each NPC's distinct background and personality enriches the game setting, enhancing player engagement and fostering natural language interactions for a more immersive experience.

3.1.2 Forms of Game Interaction. This game's core interaction utilizes the ChatGPT 3.5 AI, a large language model proficient in multilingual dialogues and prompt responses. This AI-driven dialogue system delivers tailored, realistic interactions, adapting to the player's language skills and learning curve. A specialized NPC dialogue window (Fig.1) simplifies user interaction. Players enter text in the designated input area (Fig1.h), click 'send' (Fig1.i), and receive NPC responses in the dialogue box (Fig1.g). Our game supports Chinese, English, and Japanese, easily switchable via the language selection button (Fig1.e). The complete dialogue history is available in the history interface (Fig1.a). Additionally, we provide a voice input option (Fig1.f) for more natural language engagement.

3.1.3 Game Forms Related to Language Learning. We have incorporated multiple game modes into our game to optimize the language learning experience. These modes increase appeal and practicality, while reducing language learning barriers. The following is a detailed description of these game modes:

- **Role-Playing and Real-Life Simulation**: Players take on the role of Alex and interact with NPCs in Cosmopolis to enhance language skills and cultural adaptation. This combination of role-playing and simulation eases game mechanics' learning, enriching immersion and practical learning effectiveness.
- **Instant Feedback and Assessment**: Leveraging large language models, this system enables NPCs to understand player inputs, providing feedback aligned with character traits. It includes language instruction, error correction, and cultural insights, focusing on spelling, grammar, and authentic expression (Fig2.bc). Beyond basic corrections, NPCs exhibit emotional responses. Positive NPC responses are triggered by players successfully completing dialogue tasks or aptly using complex language. Conversely, negative reactions arise from problematic expressions. This feedback method enables players to grasp their error magnitude and comprehend language expression emotionally.

3.2 Enhancing Interest in Language Learning

LUO's second core objective is to boost enhance players' interest in language learning via interactive dialogues. Addressing the monotony of traditional methods, we emphasize sustained interest as crucial for player advancement. Therefore, the game incorporates the following features to stimulate both gameplay and learning interest.

3.2.1 Setting of Open-World Environments. We created an open-world sandbox [22] to foster player engagement through dialogue and exploration, enhancing exploratory learning interest. Players have the freedom to explore different areas, each with its unique cultural characteristics and language settings, offering diverse language learning and practice opportunities. Varied designs in each area stimulate curiosity and exploration. Additionally, players can freely choose to converse with NPCs within the scenes, each with unique personalities and communication styles, offers varied conversational experiences and insights into their backstories, enriching the game narrative.

3.2.2 Multichoice Linguistic Feedback. Our game, mirroring real-world language communication, offers text and voice input, catering to player preferences and learning stages. Beginners may start with text input, easing language learning pressure, and later switch to voice for a realistic dialogue experience. NPCs feature voice output, providing both text in dialogue boxes and real-time text-to-speech conversion. This enhances players' understanding and listening skills, vital for language practice, and adds realism. The game's adaptable language feedback increases player-NPC interaction, supports various learning styles, boosts interactivity and engagement, and sustains enthusiasm and motivation for ongoing language learning.

3.2.3 Interactive Learning Experience. Interactive learning is a core feature of the game. Utilizing large language models, LUO provides a dynamic and highly interactive learning environment. Players' linguistic inputs dynamically shape these interactions, fostering natural conversation and replayability. Game progression mirrors the player's linguistic proficiency, facilitated by a leveling mechanism linking task completion and mission unlocking with experience point accrual. As players advance, dialogues and tasks grow in complexity, simulating real-world language learning and promoting ongoing improvement. NPCs adapt their linguistic complexity to the player's level, offering personalized challenges akin to a language tutor, in order to maintain motivation and interest. Additionally, the game's achievement system further enhances engagement and motivation, thus making language learning more attractive and extending game longevity [27].

3.3 Game Level Design Integrating Real-world Language Contexts

LUO's third design goal is to facilitate players' acquisition of practical language skills through gameplay. Tasks in LUO, progressively complex, vary from simple daily language to advanced dialogues and professional terms, tailored for varying proficiency levels, aligning with learning pace and augmenting language capabilities(Fig2.a).

- **Main Quests**: This game's main quests encompass the entire gameplay experience, escalating in difficulty as players advance. In the early stages, players learn basic language in common scenarios like dining, commuting, and shopping, assimilating into second language environment. Mid-levels delve into more complex conversational situations like social and academic conversations, enhancing linguistic skills and cultural awareness. Later stages focus on fluent second language dialogues, with diverse and intricate tasks like business meetings and cultural events, aiming to boost overall language competence and cultural adaptability.

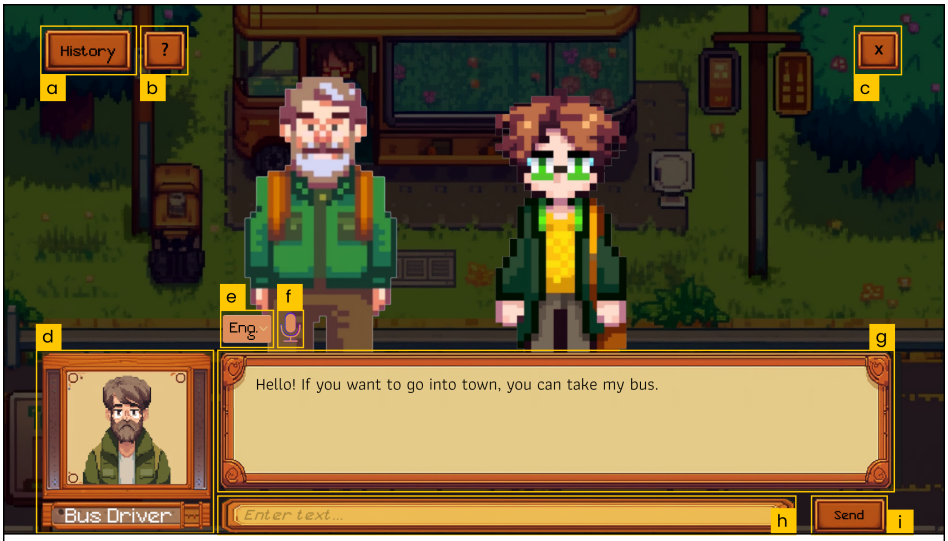

Figure 1: NPC Interaction Interface.

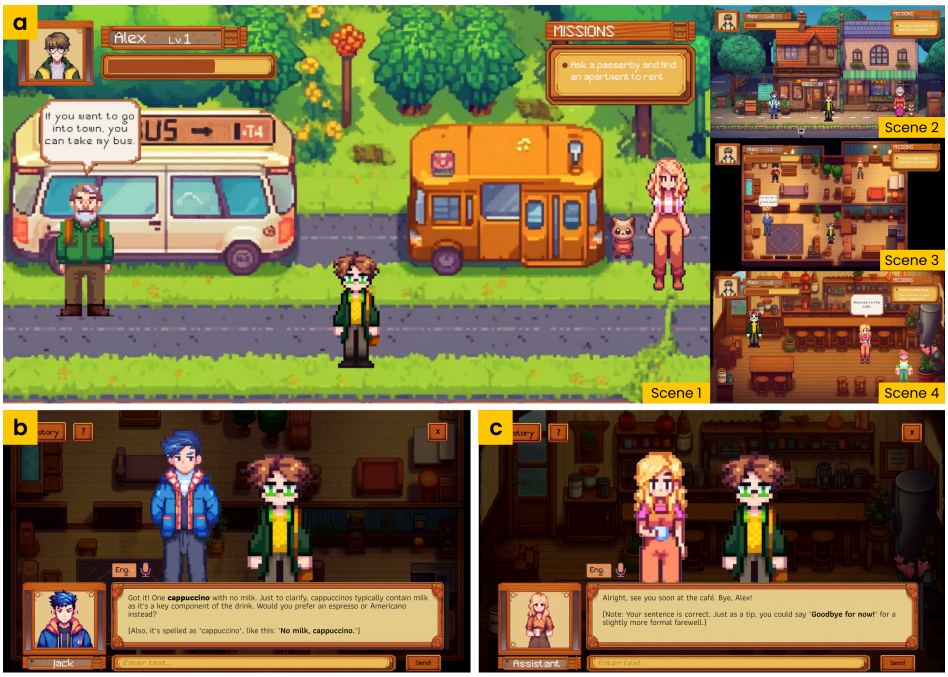

Figure 2: Game Scenes - a)Quest settings in the game interface; b)Point out misspellings or grammar in statements; c)Suggestions for more appropriate forms of expression

- **Side quests**: Besides the primary quests, the game offers multiple side quests. Distributed across various NPCs and scenes, these tasks can be initiated through NPC dialogues. Their difficulty, independent from main quests, often involves complex language usage. This feature enhances engagement and challenge, as players encounter context-specific NPCs, like those in restaurants, social events, or professional discussions, promoting practical language skills. While optional,

completing side quests becomes necessary as the main story advances, necessitating the establishment of a tier system for progression. This design balances challenging language tasks with the main storyline, encouraging more focused and professional language dialogue.

3.4 Technical Note

The game utilizes the Unity 2021 game engine and ChatGPT 3.5 AI dialogue engine, with development conducted in Visual Studio 2022. Art assets for the game, including backgrounds and NPCs, are created using Midjourney, while music and sound effects are composed using Mubert. Player voice input and NPC voice expressions in the game are facilitated by Microsoft Azure. The game is compatible with the Windows operating system.

4 PLAYTEST

4.1 Iterative Process

In the game's development, numerous iterative tests aligned the game with initial goals. NPC models, based on the ChatGPT 3.5 framework, were debugged for enhanced interaction naturalness and error correction in player communication. Concurrently, based on the trials and feedback from invited test users on the game demo, the game's system was optimized for efficient character control via simplified keys. Due to space constraints, this paper will specifically focuses on the final testing phase and outcomes.

4.2 Test plan

4.2.1 Participant. Our study involved six bilingual students in their twenties, comprising four females and two males. Half received education solely in domestic language learning environments, while the other half had experience in foreign language environments and demonstrated relatively advanced foreign language proficiency. Pre-test research indicated that most participants recognized the significance of second language expression for learners but faced challenges in achieving authentic second language expression due to various practical factors, such as "lack of real-life speaking opportunities"(P1, P3) and "self-consciousness hindering expression"(P2, P5). Furthermore, they shared their individual approaches to learning second language, with none having previously experimented with language learning through gaming. Participants' gaming proficiency varied; two had significant expertise, while four possessed basic skills.

4.2.2 Method. The study's three-phase game testing began with a pre-test survey, capturing demographic information, English learning history, and practical English application views. Participants then played the game's initial chapter and a side quest on provided computers.In the initial chapter, players embody Alex, a city newcomer, tasked with locating their rental apartment via interaction with the NPC "driver" at the "bus station." Additionally, a side quest involves procuring coffee upon a roommate's request, necessitating communication with café personnel. Players have 15 minutes for task completion, with interaction details and gameplay lag instances documented. A post-test survey followed, consisting of: 1) A subjective evaluation scale assessing attitude, educational impact, and usability; 2) User Engagement Scale-Short Form (UES-SF) and enjoyment metrics [18]; 3) Gameplay experience interviews.

4.3 Result

The testing outcomes align with our design's three objectives, showing the game substantially achieved its goals. It offered a satisfying experience, interactive language learning, and practicality. The following sections provide a detailed expansion on these aspects.

4.3.1 Low-Barrier Game Elements. To evaluate participants' gaming experiences, we utilized the User Engagement Scale-Short Form (UES-SF) and a fun assessment scale, analyzing responses on a 1-5 Likert-type scale. Overall, participants highly rated their learning experience with the game. In terms of overall system design, participants generally found the game elements (overall game style, UI icons and characters, voice and music) to be harmonious, easy to understand, and conducive to learning. The interface's simplicity, mimicking realistic dialogues, was praised. Game features like flexible storylines, open-world exploration, NPC interactions, and side quests were engaging. Participants appreciated the ability to interact with various NPCs across the map and found the difficulty level of the main quests reasonable. Comments on side quests indicated that "the random appearance of side quests adds an element of surprise" (P1, P4). We observed that participants were often able to quickly locate the NPCs in the scene based on the task instructions and successfully initiate dialogue exchanges with them. Participants found the concise game guidance effective in maintaining interest, though less experienced gamers suggested more tutorials for quicker integration (Reasonable Operation Procedure = 3.67) and clearer NPC identification for task location.

4.3.2 Enhancing Interest in Language Learning. In user engagement studies, participants generally felt immersed in the game(Time Flies = 4.83). Most found the gameplay engaging (Frustration = 1), and the relatively relaxed gaming mode (Effort = 1) combined with interesting storylines (Storyline Interest = 5) effectively captured their attention (Attraction = 5), promoting language interaction interest. Participants noted that the AI-integrated NPCs provided unpredictable, spontaneous dialogues, which enhanced the immersion of the dialogue experience, expressing curiosity about "how the NPC would correct me if I made a mistake" (P2). Furthermore, participants were eager to engage in dialogues with NPCs of different personalities, stating that "conversing with NPCs with varying tones made language expression more interesting" (P6).

4.3.3 More Natural Language Interaction. Participants generally agreed that the game was beneficial for improving English learning skills, particularly in the use of English sentence structures. For instance, most participants rated highly on the item "This game improved my ability to use English sentence structures" (4.83). The method of engaging with NPCs and receiving their corrections was favorably accepted (Acceptance = 4.83) and promoted willingness for English dialogue (Communication = 5). Experiment observations showed participants quickly corrected text based on NPC feedback, avoiding future errors. Interviews indicated perceived lifelike scenarios and practical learning content. All six participants valued the NPC conversations powered by LLMs, noting that the immediate correction of dialogue content by NPCs "made my speech more authentic" (P1) and "effectively reduced obvious errors in expression" (P3). However, some users pointed out that interactions with

Table 1: Demographics of Participants

Participants	Gender	Age	Occupation	Language Learning Time	Time in Foreign Language Environment	Gaming Proficiency (0-5)	Field of Study
P1	F	22	postgraduate	14 years	0	1	Industrial Designs
P2	F	22	undergraduate	17 years	0	1	Digital Media Technology
P3	M	20	postgraduate	12 years	0	4	Industrial Designs
P4	F	23	undergraduate	13 years	0.5 years	2	Interactive design
P5	F	22	undergraduate	13 years	3 years	5	Accounting
P6	M	22	undergraduate	16 years	1.5 years	2	Computer Science

virtual characters sometimes lacked realism, missing the subtlety and politeness found in everyday life (P4, P5).

5 CRITICAL REFLECTION

The development of LUO is focused on addressing challenges in language learning through a serious game format. Based on existing literature [5, 21], we defned the challenges to address as follows: 1) Speech processing difficulties, hindering effective language learning strategies; 2) Challenges in comprehending and applying language rules, impeding foreign language acquisition; 3) Obstacles presented by native language rule systems when learning a second language.

LUO's innovative approach addresses the limitations of traditional language learning tools like mobile and multimedia learning. Unlike these methods, which may lack depth in grammatical explanations and personalized content [28], LUO combines game-based learning with Large Language Models (LLMs) to enhance engagement and provide practical opportunities. Although LLMs offer low-cost resources and interactive practices, they fall short in fully simulating real-language environments and addressing native language influence and personalized learning needs. Integrating gamified learning with LLM technology, LUO creates a cost-effective platform for practicing language skills. It enables learners to enhance pronunciation and listening through gamified interactions and NPCs driven by LLMs, which simulate real-life contexts. This approach improves auditory comprehension and expressive abilities. LUO's tasks and activities teach grammatical rules, with LLMs providing feedback and corrections to rectify language errors. The game's various scenarios help players recognize linguistic differences, encouraging them to break free from native language patterns and adapt to new language structures. However, relying solely on LUO for language application in daily life is insufficient. Despite its potential in foreign language education, offering interactivity and immersive experiences, gamified learning has its limits. True language fluency demands real-life communication practice and validation.

6 LIMITATION AND FUTURE WORK

The post-testing evaluation of the LUO game identified key areas for improvement. Firstly, the game's voice communication lacks authentic emotional expression, hindering character personality distinction. This will affect the player's immersive experience and learning effect. To enhance this, future versions could utilize multi-speaker datasets like VCTK for training, as suggested by Gao, S., Aylett, M. P., Braude, et al., to imbue AI voice characters with distinct personalities [11]. Additionally, current large language model limitations, particularly in error correction stability during NPC interaction, prompt consideration of integrating ChatGPT-4.0 as an assistant to bolster this functionality. Moreover, we aim to augment the experience with multimodal enhancements. Implementing augmented reality (AR) to accentuate characters and dialogue, simulating realistic interactions with NPCs, promises a more authentic and precise user experience, while maintaining polite language use.Although the existing version meets educational goals, these improvements could significantly enrich the user experience. The effectiveness of these enhancements will be a focus of our future research.

7 CONCLUSION

LUO leverages serious gaming and large language models for authentic language learning. Its user-friendly error correction lowers learning barriers. Players engage in tasks from a first-person view, with NPC dialogues sparking interest. The game's realistic design simulates a practical second language environment. However, LUO's user dialogues lack the politeness and nuance of real interactions. We plan to refine the model for better conversational attitude analysis. Curiosity about NPC responses encourages active learning, but voice generation needs more realism. We aim to improve voice generation to reflect varied character personalities. LUO offers a cost-effective environment for second language communication, enriching the methods and expanding the opportunities for second language acquisition.

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