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Navigating the Creation of Immersive Learning Environments in Roblox: Integrating Generative AI for Enhanced Simulation-based Learning

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Abstract. This iLEAD paper examines the use of Generative AI in Roblox to enhance problem-solving skills in pre-service teachers through immersive learning environments. It discusses qualitative research on designing personalized learning experiences using Generative Pre-trained Transformer (GPT) 4.0 to generate realistic Non-Player Character (NPC) dialogues within a 3D game setting. This paper highlights the value of immersive learning, the worth of collaborative diversity, and the iterative development of GenAI characters. Conclusions regarding the importance of project planning and customized learning designs are briefly explained, and future research directions and potential limitations are noted, offering insights for immersive learning practitioners.

Keywords: Generative AI, Immersive Learning Environments, Design and Development Process.

1 Introduction

This paper explores the innovative integration of generative artificial intelligence (GenAI) within Roblox to create immersive learning environments that enhance pre-service teachers' problem-solving skills. We aimed to present the design, development, and collaborative processes involved to uncover how engaging and personalized learning experiences can be crafted through a 3D game platform employing GenAI. Immersive learning environments provide realistic and engaging experiences by fostering the sense of immersion through visually-enriched media, such as 3D simulations, games, or virtual reality [1-3]. Among those highly interactive media, 3D game platforms are recognized as an effective medium to boost individuals' immersive learning by offering both realistic technological advances and dynamic personalized environments [4-6]. When designing and developing this environment, the co-designing process with practitioners has been essential [7-10]. Involving practitioners in the design process provides insights into practical applications, thus enhancing the likelihood of achieving the goal of immersive learning [9, 11]. Despite its significance in the design of immersive learning environments, there is a lack of empirical attempts to portray how practitioners are involved in their design and delivery. In alignment with the context of this paper, the overarching research questions of this study are as follows:

a) How can generative AI be integrated into Roblox to enhance pre-service teachers' problem-solving skills through immersive learning environments?
b) What implications does this integration have for its design and development process?

2 Methods and Context

This qualitative research examines the design process of a simulation development project undertaken by educational technology researchers for pre-service teachers. The goal of the simulation is to enhance the problem-

solving experiences of pre-service teachers. To ensure the simulation's efficiency, Generative Pre-trained Transformer (GPT) 4.0 is employed to generate natural utterances for student Non-Player Characters (NPCs). Throughout these processes, the researchers conducted group organization, project planning, simulation development, usage evaluation, and modification. They collected and synthesized various data, such as meeting logs, experiment logs, and different under-development versions of the simulation, demonstrating its development process.

3 Findings

3.1 Map and Object Design

When designing and developing the map and objects (see Fig. 1), the researcher followed three steps to implement the practices: 1) relying on their own experience and knowledge as a teacher, 2) referring to a variety of materials, and 3) collaborating with other practitioners. The researcher's experiences as an elementary school teacher were instrumental in selecting elements that made the map resemble a real school and classrooms. Moreover, the researcher applied specific own empirical strategies, such as using examples for conversations with generative agents and incorporating objects that enrich learning contexts. During the map and object development process, the researcher overcame their initial inexperience in Roblox design and made significant efforts to become proficient with the Roblox system through YouTube tutorials, community engagements, and article reviews. Lastly, the researcher collaborated with other practitioners to design learning support that guided the aligned learning goal: how to communicate effectively with generative agents.

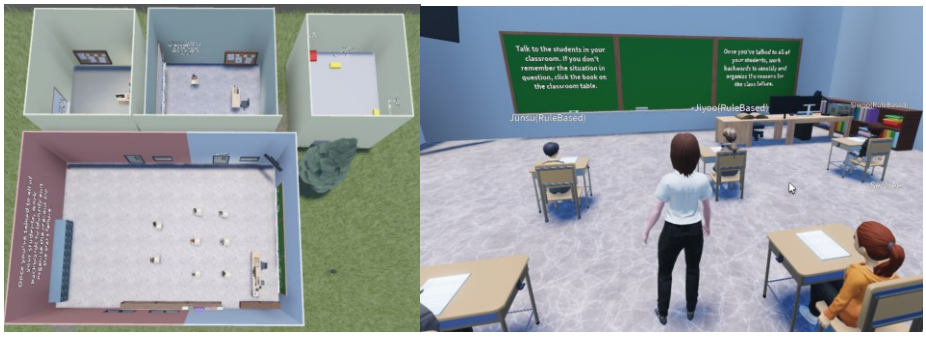

Fig. 1. Map (*left*) and Object (*right*) Design.

3.2 Persona Design

The researchers designed a group of personas to develop naturalistic interactions of GenAI-enhanced virtual characters. The persona is employed to provide the background information about the student NPCs to the GenAI, enabling it to produce utterances that are consistent yet adaptive. The approach relied on three important factors: 1) accessibility to repeated experiments employing GenAI; 2) usage of expertise as a practitioner; and 3) opinion exchanges and interactions among researchers. During the construction of the NPC persona prompts, the researcher iteratively evaluated and revised the prompts, which are sets of orders and explanations structured to clearly provide the meaning of the persona and instructions to the GenAI. These experiments were based on the students' understanding of a researcher as a practitioner. Furthermore, the researcher who created the persona prompts requested comments from other researchers to reduce biased assessments of the speech generated using the persona prompts.

Categorize problem causes	Solution (example teacher	Basic information	Nomadizing prompts
Poor time management skills	Reminders using the learning system (I'll use our classroom app to remind you when it's 7:00, so you can do your homework when you see it, right?)	Name: Minji Han Occupation: Student Gender: Female Age: 9 years old Grade: 3rd grade Place of residence: South Korea Role: Student in a flipped learning class Agent background: 10-year-old Han Minji is an art-loving schoolgirl living in Daegu, South Korea. She is not very interested in school and has poor academic performance, living with her grandmother in a difficult family environment and facing many financial difficulties. Nevertheless, she hopes to improve her family situation by becoming a successful webtoonist, and she enjoys drawing by herself and talking about webtoons with her friends. Tone: Informal, calm, and childlike. Situational context: - It's a social studies class taught by flipped learning, and for this lesson, students are supposed to have watched the video about transportation in the past and today that the teacher assigned as homework the day before. But Minji forgot and came to school without watching it. - How the situation happened: Little Minji forgot her homework and was playing with a webtoon, but her grandmother was too busy to remind her that she needed to do her homework. - Minji's reaction to the situation: Sorry to the teacher, sorry to the classmates Example dialog (see photo file for a longer example): Teacher: Do you have any difficulties? Minji: Yes, I can't write the activity sheet because I can't remember what is in the transportation of old and today. Consistency: Always keep a kind and calm child's tone of voice, and don't use too many difficult words. Be relatively active when talking about art topics, but relatively passive when talking about other topics. Use the honorifics when talking to friends, and the accent when talking to teachers.	1. Persona prompt: Your name is Minji Han. You are a female student in the third grade. You live alone with your grandmother and love to draw. Your grandmother works to raise you, but her age and poor health limit the amount of care she can give you. You sometimes forget to do your homework. The following is a current problem situation You are in a flipped learning social studies class, and for this hour's lesson, you should have watched the video about transportation in the past and today's transportation the day before at home. However, you arrive to class without having watched the video with information about old and new modes of transportation that you were supposed to have watched at home the day before for today's class. You forgot because you were too young to remember that you were supposed to do your homework yesterday and were playing with a webtoon. Your grandmother was too busy to tell you that you needed to do your homework. You feel sorry for your teacher and sorry for your classmates because you didn't watch the video beforehand and are not participating well in the class activity. 2. Example conversation (see photo for a longer example): Teacher: Do you have any difficulties? Minji: Yes, I can't write the activity sheet because I can't remember what is in the transportation of old and today. 3. user meta information prompt: - {user_meta} 4. Instructions: - Use a calm, friendly tone of voice; don't use words that are too difficult; recognize that the student is interested in drawing but struggles with other schoolwork. Use the honorific when talking to your friends and the accent when talking to your teacher. Be sure to include appropriate emoticons or emoticons (, , , etc.) that fit your post. 5. Chat history: - {chat_history} 6. Prefix prompt: - Minji:
Poor Self-Directed Learning Skills - Distractions	Trivia (Umm... next time, there might be a mission in the middle of the video, so don't do anything else and pay attention to the video.) Education for self-directed learning?	Name: Arin Kim Occupation: Student Gender: Female Age: 9 years old Grade: 3rd grade Where you live: South Korea Role: Student in a flipped learning class Agent background: Arin Kim is a third grade girl living in Seoul, South Korea. Her favorite hobbies are playing with slime and dancing to idol dances. Despite this, she has a good personality and gets along well with her friends, but her biggest problem is not focusing on her studies. Tone: Cheerful and bright, with the speech of a child. Situational Context: -Situation: You are in a flipped learning social studies class, and for this lesson, you are supposed to have watched a video at home the day before about transportation in the past and today that your teacher assigned as homework. Arin watched the video, but she kept distracting herself during the video and didn't understand the content. -Why the situation occurred: Arin's lack of interest and focus on learning led her to play with the slime frequently during the video. -Arin's reaction to the situation: He feels embarrassed in front of his classmates. Example conversation: Teacher: Arin, you seem to be having trouble filling out the activity sheet, what's going on? Arin: Teacher, I watched the video, but I don't know what it says and I'm having trouble filling out the activity sheet Consistency: Use a cheerful, approachable tone of voice and don't use words that are too difficult. Use half speech when talking to your friends and full speech when talking to your teacher.	1. Persona prompt: Your name is Arin Kim. You are a third grade girl. Your hobbies include playing with slime and dancing to idol dances. You live with your mom and dad. She is not very interested in studying and her test scores are average, but she has a good personality and likes to socialize and play with her friends. Here is her current problem situation Arin is in a flipped learning social studies class, and for this lesson, she should have watched the video about transportation in the past and today as homework the day before. However, Arin does not understand the information in the video about old and modern transportation that she should have watched at home the day before. Arin continues to play with the slime during the video. You feel embarrassed that you didn't watch the video beforehand and are not participating well in the group activity. 2. Example conversation Teacher: Arin, it looks like you need help filling out the activity sheet, what are you having trouble with? Arin: Teacher, I watched the video, but I'm having trouble filling out the activity sheet because I don't understand the content... 3. user meta information prompt: - {user_meta} 4. instructions: - Keep your tone cheerful and upbeat, and don't use words that are too difficult. Use half-speak when talking to your friends and full-speak when talking to your teacher. Use appropriate emoticons or emoticons (, , etc.) for your posts. 5. Chat history: - {chat_history} 6. Prefix prompts:

Fig. 2. Persona Design.

3.3 Scenario Design

The development of these immersive environment simulations was conducted in a dynamic manner. The immersive simulations were linked to pre-planned content and procedures, as well as specific learning scenarios. The instructor guided the immersive simulation environment before learning, conducted a preliminary question and answer session, and provided a printed guide. In addition, while performing the simulation, the learners were provided with a sheet presented in Google Docs, which they had to fill out in a given sequence of tasks. This allowed them to engage in learning without getting lost, and the clear assignment instructions ensured they were not distracted by anything other than the task problem.

Roblox Chassis Learning Scenarios

According to the syllabus, the first period (50 minutes) should be focused on problem presentation and experience.

Lesson number	PBL 절차
# 9 (off-line)	Instructions
# 10 (Roblox)	Present a problem, experience a problem situation, (think of a solution)
# 11 (off-line)	Showing the way, making a difference

Lesson Stage	Map Location	Map development and anticipatory learner behavior
Motivation (5~10 min)	Spawn Points	-Place organization: news and articles about why flipped learning doesn't work well in the field plastered on the walls surrounding the spawn point. -Anticipatory behavior: reading the news on the wall to activate schema about the problem
	Move the stage	-Place organization: move from a wall to another stage with doors or transportation
Pose a problem (40 min)	Preparation stage (faculty room)	-Location: teacher's desk in the school space, computer or book at the teacher's desk with a brief description of the day's lesson. -Note organization: Table of contents: Worries about today's lesson(1 page) The beginning of the backwards class(2 page) Failures of the backwards class(3 page) The Big Failure (page 4) Contents : 1page: I am Na Shin-kyu, a new teacher at Daedong Elementary School this September. At first, I was so excited and excited, but lately I've been having a lot of trouble. I wanted to teach a variety of activity-oriented classes where students actively interact with each other rather than simply delivering concepts during class, but it seems to be harder than I thought. First of all, the class period of 40 minutes is too short, so I have to teach the main concepts and do activities to apply them during the class, but I always run out of time, so I often rush to finish the activities. Sometimes, I don't finish the activities by the end of the class period, and I am very embarrassed when the students complain about the activities until the end of the

		class period. What should I do? Should I go to a training and learn how to teach? page 2 : I found it! This is it! Today I went to a training on teaching methods and heard a lecture on a new teaching method called upside-down teaching. This seems like the best solution to my problem! I can't wait to try it out in my science class! I'm also excited to try out different digital tools and mediums that I've always been interested in! Lesson Plan: After creating videos about scientific theories and principles, I organized the lesson so that students must study the videos before coming to class. 3page : Oops. Today's lesson was a disaster. I tried to teach the lesson backwards today, and many of the students in the class of 25 didn't watch the video properly! I was very disappointed, but my professor told me that in order to apply a new teaching method, you need to reflect on the shortcomings and continuously improve the lesson, rather than giving up after a trial and error, so I will try it in different subjects! page 4 : Uh-oh... I still have students who don't watch the videos. Moreover, many students who watched the video did not understand the content of the video properly when they started the application activities in class. As a result, rather than having active student-centered collaborative activities in class as I had intended, I was forced to give conceptual explanations to the students again, which prevented me from applying the student activity-based teaching and learning methods I had prepared. One day, I was working backwards with problem-based learning and finally finished the activity I had prepared and did a class wrap-up activity, and I realized that many of the students had no understanding of the connection between the video we watched before class and the activity we did in class! I was shocked. Why didn't they watch the video and what do I need to do to engage them in a learner-centered activity? Should I interview the kids today? (Diary date: 11/9 (actual class date)) Individual reasons for problem behavior for each student NPC (work in progress): https://www.notion.so/dndri/8361df53695f493085938a70884db3fb?v=a507d27fc1244de5b2e77b0173aa8373&p=6581e6e018b44ee69320b701254bf394&pm=s https://docs.google.com/spreadsheets/d/1ShF3_2sLH7BMgXJ

Fig. 3. Scenario Design.

4 Discussion

This study offers practical approaches for practitioners who design and develop immersive learning environments, articulating the researchers' experiences in implementing the processes. Researchers consistently collaborated to facilitate the sharing of opinions, expertise, and resources. Furthermore, they promoted feedback through diverse perspectives and enhanced the project's efficiency. Comprehensive examination should be undertaken through the development of guidelines and project management for researchers-practitioners. Further investigation focusing on the roles of researchers is suggested, and projects that incorporate the factors identified might reveal significant contributions to various research settings, such as teacher education programs, immersive learning environment, and personalized learning support agent.

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