SENEM-AI: Leveraging LLMs for Student Behavior Simulation in Virtual Learning Environments

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Abstract

SENEM-AI is a 3D virtual environment-based tool designed to enhance teaching and presentation skills by leveraging immersive simulations. Built upon the SENEM platform, it integrates virtual students powered by LLaMA with distinct personalities that simulate realistic classroom interactions. Educators can refine their communication strategies by reacting to dynamically generated questions. Preliminary evaluations highlighted its usability and potential impact, with participants valuing the immersive experience and engagement. SENEM-AI represents a novel approach to supporting educators through accessible technology, paving the way for further research into AI-driven teaching aids and training environments in virtual settings.

Tool video: `https://www.youtube.com/watch?v=uHg25Gooi58`

Keywords: Virtual Learning Environment, Students Simulation, Teacher Training, LLM Agents

Metadata

1. Motivation and significance

The application of artificial intelligence (AI) in educational contexts has been extensively studied [1], focusing on its potential to enhance teaching activities in various ways, such as generating instructional materials [2], creating assessment tools [3, 4], and designing personalized learning experiences for students [5]. This area of research has experienced significant momentum with the advent of Large Language Models (LLMs), which have made it even more efficient to leverage AI capabilities to support educational settings. However, most research efforts have predominantly targeted the student perspective: LLMs have been widely utilized for diverse educational aspects,

Nr.	Code metadata description	Metadata
C1	Current code version	v1.0
C2	Permanent link to code/repository used for this code version	`https://github.com/vipenti/SENEM_Metaverse`
C3	Permanent link to Reproducible Capsule	NA
C4	Legal Code License	Common Development and Distribution License 1.0
C5	Code versioning system used	git
C6	Software code languages, tools, and services used	Unity3D 2021.3.22f1, C#, Python 3.9
C7	Compilation requirements, operating environments & dependencies	All the detailed dependencies are reported here: `https://github.com/vipenti/Smart_Student_Server/blob/main/requirements.txt`
C8	If available Link to developer documentation/manual	`https://github.com/vipenti/SENEM_Metaverse/blob/main/README.md`
C9	Support email for questions	vpentangelo@unisa.it

Table 1: Code metadata

such as enhancing students' critical and reflective thinking skills [6], providing on-demand customized assistance [7], or performing automated students' scoring [8, 9]. Currently, limited attention has been directed toward the sole **teachers' perspective** when it comes to improving their skills as educators and communicators. Indeed, remarkably little work has focused on providing simulation tools and settings targeted to educators [10, 11].
In this paper, we aim to overcome the aforementioned limitations by presenting SENEM-AI, a tool leveraging a virtual environment setting and LLaMA [12] to assist teachers and presenters in training their educational and presentational skills. Within the virtual environment are smart students, powered by LLaMA, each with distinct personality traits that enable them to listen to and interact with the speaking user. SENEM-AI has been designed as a training environment for educators: through our tool, instructors can obtain samples of questions and interactions related to the instructional content they are presenting to prepare and perfect by anticipating and practicing the questions generated by smart students.
SENEM-AI offers a preliminary perspective on how LLMs can simulate realistic student behavior, paving the way to different research contributions.

Specifically, examples of empirical investigations are: (1) evaluating the credibility and behavioral realism of LLM-powered virtual students, to assess their potential use in diverse educational simulation settings; (2) studying the impact of immersive environments on teacher training and communication skill development, through controlled experiments; and (3) exploring how simulated classroom interactions can foster the iterative improvement of teaching practices and how these practices may be integrated into remote or hybrid educational formats.

Built on the metaverse-like platform SENEM [13], a collaborative virtual environment designed to enhance remote learning, SENEM-AI extends its capabilities by integrating intelligent agent simulations for a more interactive and engaging teaching experience, providing educators with an innovative tool to support their activities. Such a tool will also serve as a foundation for future research into the behavior and realism of intelligent students, also by offering a practical, ready-to-use environment for testing AI-driven educational strategies in immersive settings—in line with the definition provided by Suh and Prophet [14], which characterizes immersive systems basing on sense of presence, interaction, and realism in simulated environments, SENEM-AI provide a moderate but meaningful immersive experience. This includes first-person navigation within a 3D classroom, live microphone-based voice interaction, and responsive virtual agents powered by LLMs.

The shift toward online education during the COVID-19 pandemic has sparked renewed interest in virtual learning environments and their pedagogical implications. Recent large-scale analyses of public discourse on social media have highlighted both the increasing reliance on online learning tools and the complexity of public perception surrounding them—ranging from supportive attitudes to concerns about accessibility, effectiveness, and emotional impact [15, 16]. Nonetheless, literature has proven the effectiveness of immersive simulations for teaching activities [17, 18]. Beyond SENEM, on which SENEM-AI is based, other immersive educational platforms have been proposed in the literature, primarily taking into account students' needs for sociality and interconnectivity [19] or enhancing their learning experience [20, 21]. From the simulative perspective, work has focused on proposing models to design students' behavior [22], and AI has been used to implement such models. As examples, Bhowmik et al. [10] presented Evelyn AI, a GPT-3.5-based agent capable of interacting with teachers by combining domain knowledge and short-term memory, but primarily focused on standalone textual interactions rather than integration within immersive environments. Li et al. [11] proposed SimStu, a transformer-based simulator that generates behavioral data to train Intelligent Tutoring Systems (ITS) via synthetic student modeling. While SimStu demonstrated strong similarity to real student behavioral patterns, it is not designed for real-time interaction with human instructors, nor does it operate within immersive or visually grounded simulations. In contrast, SENEM-AI provides a fully operational, modular framework that integrates LLM-driven student agents into an immersive 3D classroom simulation, enabling real-time, voice-based interaction with teachers. Building on the foundations posed by prior works that focus on data generation [11] or conversational agents in isolation [10], our framework emphasizes usability, presence, and pedagogical plausibility, with configurable student personalities to explore variability in classroom dynamics. SENEM-AI thus aims to bridge the gap between AI-driven behavioral simulation and practical teaching support tools in virtual training environments.

2. Software description

SENEM-AI is a virtual training tool leveraging LLaMA-based smart students with distinct personalities to assist educators in honing teaching and presentational skills. We envision our tool as a demonstrative and modular framework, designed to showcase the integration of LLM-powered agents in immersive educational environments. Rather than providing an exhaustive implementation of all possible configurations, the tool aims to serve as a foundation for future experimentation and customization by the research community. Table 1 summarizes the tool's main information. It integrates immersive virtual environments and AI simulations, enabling educators to anticipate and practice interactions, enhancing both realism and engagement in instructional scenarios. Specifically, the platform incorporates smart students, represented as virtual avatars within the scene, capable of performing actions such as listening, raising their hands, and speaking. SENEM-AI builds upon the SENEM platform, which leverages the Unity3D[1] graphics engine for the virtual environment and PUN Voice[2] library to allow user audio communication. The AI capabilities are enabled through a web server implemented with Flask[3], which mediates requests to a module powered by LLaMA, functioning as the "brain" of the virtual students. The system prompt explicitly instructs the LLM to simulate a student by following four personality parameters (extroversion, intelligence, interest, and mood). It specifies the lecture topic and provides clear behavioral rules: the agent can answer the professor or ask relevant clarification or follow-up questions,

[1] `https://docs.unity3d.com/6000.0/Documentation/Manual/UnityManual.html`

[2] `https://doc.photonengine.com/voice/current/getting-started/voice-for-pun`

[3] `https://flask.palletsprojects.com/en/stable/`

given the pre-defined lesson's topic. Such prompt will be easily configurable and customizable, allowing researchers to test different prompting strategies and LLM models according to their needs. SENEM-AI is built on the SENEM platform, SENEM-AI combines Unity3D[4] for its virtual environment and PUN Voice[5] for audio communication. Virtual students, powered by a Flask-based[6] web server and LLaMA, exhibit diverse personality traits and behaviors, enabling realistic interactions such as listening, raising hands, and asking questions.

2.1. Software architecture

Figure 1 summarizes the architecture of SENEM-AI, which is composed of three main modules.

1. **SENEM**. This module incorporates virtual students into the existing SENEM platform. Each student entity listens to incoming audio on the platform and has a probability of interacting with the server based on their personality parameters.
2. **Web Server Module**. This Python-based backend acts as the central processing unit for all intelligent student interactions. It receives the teacher's live audio via HTTP requests triggered from Unity, uses a speech-to-text module to transcribe the input, and combines it with personality parameters (stored in JSON format) associated with the selected student. The server constructs a structured prompt using this information and sends it to the LLM module. Once a response is returned, the server uses a text-to-speech engine to synthesize the audio, which is streamed back to the Unity environment through Photon Voice for playback.
3. **LLM Module**. This module integrates LLaMA and provides an interface for querying the model. It receives POST requests from the Smart Student Server containing structured prompts and student metadata. The service processes these inputs to generate context-aware, personality-aligned responses. The architecture allows for easy model replacement by simply redirecting the API endpoint, making the system agnostic to the underlying LLM implementation. Additionally, the prompt construction logic is modularized to support plug-in strategies for different dialogue patterns or interaction scenarios.

[4] `https://docs.unity3d.com/6000.0/Documentation/Manual/UnityManual.html`

[5] `https://doc.photonengine.com/voice/current/getting-started/voice-for-pun`

[6] `https://flask.palletsprojects.com/en/stable/`

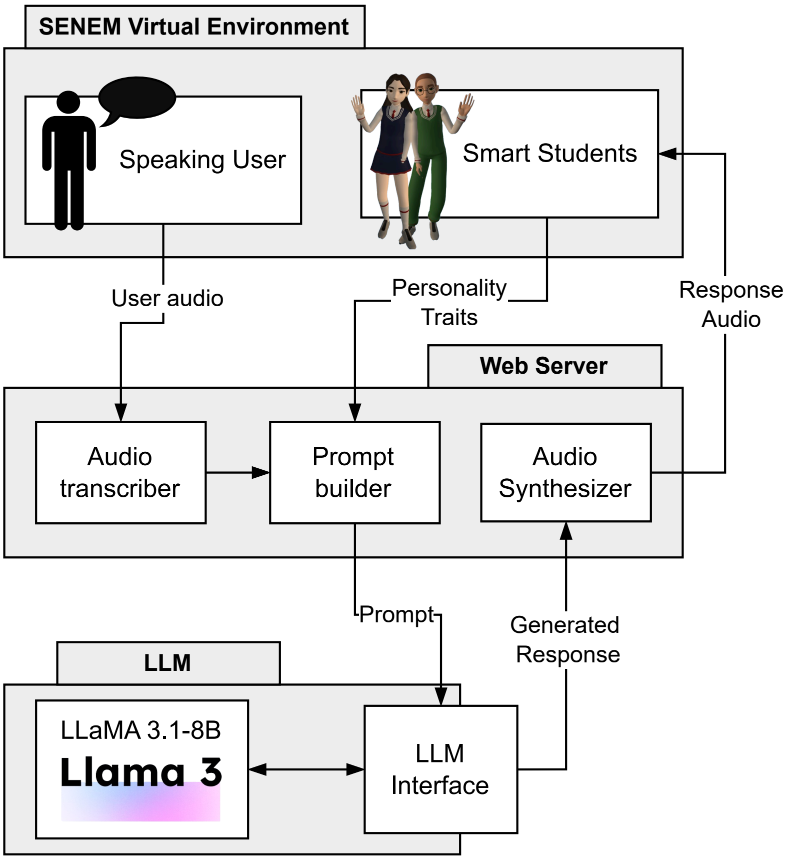

Figure 1: Overview of SENEM-AI's architecture.

Overall, the architecture ensures dynamic interaction between the modules to enable a real-time student behavior simulations. Moreover, the three modules were designed to function independently: in future work, any virtual environment can be connected, or the LLM can be replaced with other models for further studies and evaluations.

2.2. Software functionalities

When users access SENEM-AI, they explore it freely through a first-person camera perspective. They can use their microphone to enable their avatar to speak, send text messages, or use emotes. Inside the classroom, they will find a number of students corresponding to the selection made at the beginning. Each student is assigned a randomly generated personality, defined by four parameters rated on a scale from 1 to 5—1 representing the lowest value for that trait and 5 the highest. These parameters include: (1) personality, indicating the degree of introversion or extroversion; (2) interest in the lesson topic; (3) intelligence, reflecting the ability to formulate relevant thoughts and questions; and (4) mood, ranging from sad to happy. The selection of these four parameters is inspired by prior work in affective computing and educational agent design to promote believable and pedagogically meaningful interactions [23, 24, 22]. The adopted 1–5 scale reflects a Likert-style measurement, widely used in behavioral and UX modeling [25]. These parameters are passed to the LLM when it generates a response, influencing how the students communicate. The students can either respond to direct questions posed by the speaking user or formulate their own questions or requests for clarification about what they are hearing. The user can decide to allow the students to speak in the order their questions are generated, whenever they prefer. The user can quit the session whenever they want and will find a log of the interactions with the students stored on the device.

3. Illustrative examples

In this section, we present an illustrated example of how a simulation session is conducted using the tool. We also made a video showcasing a brief illustrative session[7].

The login screen of the tool, shown in Figure 2, prompts the user to specify ① a nickname, ② the lesson topic, and ③ the number of virtual students present in the classroom. Users can customize their avatars by accessing the editor via the ④ designated button. Finally, the user can enter the virtual classroom by pressing the ⑤ "Create" button.

Upon entering the classroom, as shown in Figure 3, the user is presented with ⑥ a virtual class with the selected number of students, each with a randomly generated appearance and personality. Above each student's head is an indication of their personality and the corresponding probability of generating a question—this can be hidden to enhance immersion. In the top-right corner, ⑦ the microphone status of the user is displayed, indicating whether the platform is detecting audio. If active, each student listens for possible questions or interactions.

When a student generates a question, they raise their hand. In Figure 4, ⑧ a student with a raised hand is depicted. The user can choose, via a specific command, to allow the student to speak. The student then ⑨ plays the audio using a speech synthesizer and simultaneously shows a transcription.

[7] https://www.youtube.com/watch?v=uHg25Gooi58

Figure 2: Login screen of the tool.

4. Impact

This section presents the initial and preliminary evaluation of the tool and its potential impact on both the research and academic worlds.

4.1. Tool Evaluation

To evaluate the potential of the tool and test its usability and functionality, a preliminary in-vitro evaluation was conducted. Specifically, a usability testing approach was employed [26]. Such a choice was motivated by two main reasons: (1) it is particularly appropriate for evaluating early-stage software tools, and (2) it is also well-established in the literature for assessing usability in tool-focused research [27, 28, 29]. Moreover, since our primary objective was to explore the usability and user experience of SENEM-AI—rather than to assess learning outcomes or long-term effects—this approach allowed us to efficiently detect usability issues, gather qualitative feedback, and apply iterative refinements to the tool.
The participant sample included a mix of students and tutors, as the goal of this preliminary evaluation was to assess the overall usability and perceived effectiveness of the tool, rather than to draw conclusions about specific user categories. We recruited six participants using convenience sampling approach, from our network. We acknowledge that it is a small sample size that undermine highly generalizable conclusions. The goal of our evaluation is to gather preliminary feedback on the tool's usability; a more comprehensive empirical study—potentially including control groups and standardized

Figure 3: Smart Students in the virtual classroom.

assessment instruments—will be necessary to fully assess the tool's educational impact. The six participants were gathered in a laboratory setting and tasked with delivering a presentation of their choice within the SENEM-AI environment, which included a number of AI agent participants. Each session lasted approximately 15 minutes and involved a single participant using SENEM-AI. Participants freely controlled the timing and number of AI-generated questions and were advised to include between 5 and 10 virtual students for realism and manageability. All student personalities were randomly generated at runtime to simulate classroom diversity. Real and virtual students were not mixed within the same session to avoid confounding usability observations. During the session, participants presented their content and responded to questions posed by the AI agents. Upon completing their presentations, each participant was asked to fill out a questionnaire designed to collect (1) demographic information, (2) the metrics described earlier—measured using Likert scales ranging from 1 to 5, and (3) qualitative feedback and suggestions for improving the experience [30]. We acknowledge that a more targeted sampling strategy will be necessary in future studies, particularly when evaluating the pedagogical impact of SENEM-AI on different educator profiles.

The evaluation focused on three main aspects: (1) the credibility and coherence of the experience, particularly assessing how believable the questions and reactions of the AI agents appeared; (2) the participants' willingness to use the software for future sessions; and (3) the usability of the software in terms of its intuitiveness. Additionally, user suggestions for potential im-

Figure 4: On the left, a student raising their hand; on the right, the same student asking their questions after the user's input.

provements were collected.
The results revealed a balanced perspective regarding the tool's performance. Half of the participants rated the agents as not very credible or coherent (scores less than 2), while the other half found them reasonably coherent (scores greater than 3). A similar distribution was observed when assessing the quality of the questions posed by the agents. Additionally, the majority of participants (five out of six) expressed that they would use SENEM-AI in combination with other tools for practice, while only one participant indicated they would not. Participants highlighted several aspects of the tool that they appreciated, including the ability to move freely within the virtual space during their presentations, the interaction with a "sentient" audience that made the experience more engaging, and the stimulation to delve deeper into the topic through specific questions. Moreover, the realistic atmosphere provided by the tool, which reduced the feeling of speaking to an empty room, and the utility of the tool for practicing future presentations were particularly valued.
In terms of usability, five participants indicated a willingness to reuse the tool (Likert scores >3), while only one participant expressed reservations (score $= 2$). Suggestions for improvement included adding a button to signal the end of an answer and providing more feedback when responding to student questions. Other recommendations involved generating more relevant and coherent questions and slowing down the pace at which questions are asked. Participants also proposed additional features to enhance the tool's effectiveness as a preparation aid. These included the ability to edit slides directly within the program, integrating a video playback function, and as-

signing unique names to the AI agents to facilitate smoother voice-based interactions.

These results align with expectations, as the tool represents a pioneering effort in leveraging AI to support educators and academics within a virtual environment. Regarding the believability of the virtual agents, the mixed feedback from participants highlights current limitations in LLM-based student modeling. We interpret this as a diagnostic insight rather than a failure, as it reflects broader challenges in simulating human-like behavior using generative models. Improving the coherence and realism of agent interactions represents a key direction for future development.

4.2. Potential Impact

SENEM-AI was designed to provide meaningful contributions to both research and professional practice.

From a research standpoint, SENEM-AI offers a versatile platform to explore innovative approaches for training presenters and educators. Its adoption can be investigated through established frameworks, such as the Diffusion of Innovation theory [31] and the Technology Adoption Model [32], while user satisfaction studies can further validate its effectiveness. Additionally, controlled experiments could be conducted to assess its utility and identify limitations, offering opportunities for iterative improvement and refinement. Furthermore, SENEM-AI represents an initial step towards operationalizing AI to assist educators in a simulated environment. Future research could enhance SENEM-AI's capabilities by incorporating diverse models and using advanced AI prompting or software engineering techniques, all aimed at better supporting professionals [33].

From an educator's perspective, the tool not only facilitates the simulation of presentations and lectures but also aims to democratize access to immersive training environments. In practical terms, SENEM-AI can support educators during the lesson preparation phase by offering a low-risk, realistic environment where to rehearse their content. Before delivering a lecture—whether in-person or remote—teachers can use SENEM-AI to simulate interaction with a virtual audience that asks spontaneous questions. This has the potential to allow them to refine their communication strategies and their readiness to manage unexpected inputs and clarify complex topics in real time. Integrating this simulation into the typical preparation workflow could improve both the educator's confidence and the overall clarity and engagement of the lesson, ultimately benefiting students' learning outcomes. In line with the educational practice of 'learning by doing,' SENEM-AI can complement courses for educators, facilitating their educational journey and maximizing their potential impact on new generations of students.

As for the tool's limitations, we acknowledge that our current implementation does not include a formal validation of whether different personality configurations lead to distinguishable student behaviors. Investigating this relationship remains a critical next step in our research roadmap and will be explored in future empirical studies. Moreover, the evaluation's limitations could be addressed by future rigorous experimental designs—such as pre/post evaluations or controlled comparisons—to assess the actual impact of SENEM-AI on teaching skill development. Finally, we recognize the inherent limitations of LLMs, including the potential for generating factually incorrect or incoherent outputs, such as the concrete possibility of hallucinations [34]. In this sense, SENEM-AI is conceived as a demonstrative, modular framework rather than a validated implementation of a specific LLM. We envision it as an infrastructure that will allow the integration of alternative models and prompts, making it a foundation for future research on hallucination control, grounding, and prompt engineering.

Regarding ethical considerations, we acknowledge that the growing realism of AI-driven simulations—particularly in scenarios involving sensitive behaviors such as emotional distress or aggression—raises important ethical challenges. While the current implementation of SENEM-AI is intentionally restricted to controlled, non-sensitive training contexts, future extensions of the tool will need to be accompanied by well-defined ethical guidelines, explicit content boundaries, and safeguards to prevent potential misuse. Addressing these aspects will be essential to ensure the responsible and pedagogically sound use of AI in educational environments.

5. Conclusions

In this study, we presented SENEM-AI, a simulation-based tool designed to support educators in developing their communication and teaching skills through interactions with LLM-powered virtual students. Our work focused on the design and implementation of the tool, as well as on evaluating its usability and perceived effectiveness through a preliminary study. On this basis, SENEM-AI lays the groundwork for a wide range of future research directions, including empirical studies on its pedagogical impact, comparative evaluations of different AI models, and investigations into its integration within real-world educational workflows.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to improve the paper's readability. No part of the text in the paper was initially and entirely generated by an AI. After using the service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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