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The design and use of conversational intelligent tutoring systems and computer simulation for the use of students of technology entrepreneurship

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Abstract: Entrepreneurship is complex and dynamic. It involves continuously pursuing novel or better products and business models amidst constraints, uncertainty, and constant change among ecosystem participants (or "agents"). Entrepreneurship education, therefore, needs to be non-linear. Yet, traditional teaching methods in entrepreneurship came from business management education practices: lectures, case studies, and group discussions–mostly ineffective because entrepreneurship is more dynamic and non-linear. Recent entrepreneurial experiential learning attempts include starting and running a business and using computer simulations to reduce time and cost. There are opportunities to introduce non-linear and more human-like approaches to the learning interface, and these are some of the aims of intelligent tutor systems (ITS). This study proposes using a conversational ITS (CITS) as the learning experience interface for a technology entrepreneurship program to teach students various concepts. Conversations, through natural language, will take advantage of recent developments in large language models (LLMs) and related conversational agents and AI assistants such as ChatGPT. At the heart of the learning tool is a suite of computer simulation environments specifically for technology entrepreneurship, with the choice of technology entrepreneurship forcing novelty and relative market uncertainty in product offerings. The design and selection of technologies will follow evaluation frameworks on the effectiveness of entrepreneurship teaching simulation environments: fidelity, verification, and validity. The expected output will be a simulation environment resulting from multiple design-build-implement iterations. The CITS and the simulation core engine shall interface with a Learning Management System (LMS). The study will also generate insights after simulation sessions with domain experts and students through educational data mining (EDM) of the resulting logs.

Keywords: conversational intelligent tutoring systems, CITS, large language models, llm, GPT, computer simulation, entrepreneurship education, agent-based modeling, agent-based simulation, ABMS

1. Introduction

Entrepreneurial education is crucial in fostering economic growth, yet it lacks many aspects to make it more effective (Allegra et al., 2013). Entrepreneurship is a complex, chaotic, non-linear, and dynamic process of vision, change, and creation; therefore, it is more than business creation and management (Neck & Greene, 2011). The typical teaching methods in entrepreneurship classes are those used in business: lectures, case studies, and group discussions–all ineffective when teaching entrepreneurship, which requires more active learning approaches (Tasnim & Yahya, 2013). Entrepreneurship education has expanded with business plans, consultation with practicing entrepreneurs, and computer simulations (Kuratko, 2005). This study focuses on computer simulation with a conversational interface. A *simulation* is a self-contained immersive environment in which the learner interacts within the environment to learn or practice skills or knowledge. Simulations allow cost-effective and

less time-intensive training than a real (business) scenario (Kapp et al., 2014). Certain simulations also induce the state of flow (Csikszentmihalyi, 1988) during sessions (Almeida & Buzady, 2019). This study aims to design and observe the usage of a computer simulation environment intended for technology entrepreneurship students. The choice of technology entrepreneurship implies novelty and market uncertainty in product offerings. Agent-based Modeling and Simulation (ABMS) covers interactions among independent agents (Macal & North, 2005). An *agent* is an autonomous individual that can behave and decide independently. Simulation environments may be facilitated through human teachers or computers. *Conversational Intelligent Tutoring Systems (CITS)* are e-learning systems that deliver tutorial content through discussion, asking and answering questions, identifying gaps in knowledge, and providing feedback in natural language (Holmes et al., 2017). Generative artificial intelligence (GAI) is a machine learning framework that generates content using probability and statistics based on existing digital content such as text, video, images, and audio through training examples, thus learning their patterns and distribution (Baidoo-Anu & Owusu Ansah, 2023). A large language model (LLM) is a GAI and statistical model of the distribution of tokens in the vast public corpus of human-generated text (Shanahan, 2023). Generative Pre-trained Transformer (GPT), an LLM-based system, generates or statistically predicts sequences of words, code, or other data, starting from a source input called the prompt (Floridi & Chiriatti, 2020). GPT is based on the *Transformer* (Vaswani et al., 2017) deep neural network architecture. A conversational agent or AI assistant based on LLM is ChatGPT, a conversational interface to GPT (Zhai, 2022). A common pattern nowadays is turning an LLM into a question-answering system by a) embedding it in a larger system and b) using *prompt engineering* to elicit the expected behavior (Shanahan, 2023). This paper is a major enhancement from the previous submission (Ilagan, 2022). The change is the focus on using an LLM-based CITS approach instead of a non-conversational interface.

The following questions properly establish the significance of the study: **RQ1)** What features must be present when designing and implementing conversational intelligent tutoring systems and simulation platforms for entrepreneurship education? **RQ2)** How would the efficacy of conversational intelligent tutoring systems and agent-based simulation modeling be measured based on learning outcomes? **RQ3)** How may a conversational intelligent tutoring system complement a set of human instructors and mentors for entrepreneurship education? *How can intelligent tutoring systems, through advances in conversational support of generative AI, be designed to enhance and spark interest in entrepreneurship education? What are the limitations of an LLM, and how can these gaps be addressed in the CITS that embodies it?* The hypotheses are as follows: 1) Incorporating regular feedback and question prompting in conversations will lead to improved learning outcomes over traditional methods of teaching entrepreneurship. To test this hypothesis, students' assessment results using a non-conversational front-end vs. a conversational front-end will be administered and analyzed at the end of the learning session. 2) An ABMS incorporating realistic and interactive entrepreneurial scenarios will enhance students' understanding and application of entrepreneurship principles, leading to improved learning outcomes over traditional lectures and case studies. 3) A CITS that complements human instructors and mentors in entrepreneurship education will improve learning outcomes by providing additional support and guidance to students. 4) A simulator will spark interest in learning technology entrepreneurship.

2. Related Work

Neck & Greene (2011) offer an approach involving entrepreneurship as a *method* in contrast to a *process*, which implies predictability. Some methods are starting a business, design-based learning, and reflective practice. Another set of methods uses simulations, multimedia instruction, and interactive activities to compact the business creation process (Tasnim & Yahya, 2013). Hindle (2002) finds that experiential learning is a vital component of entrepreneurship education but also raises the issue involving the timeframe of a business venture exceeding an academic subject's term duration and how simulation can help. Work

involving ABMS involves economic activities such as supply chain recovery (Rahman et al., 2021) and Rogers's (1983) theory of diffusion of innovations (Meade & Islam, 2006). ABMS software like NetLogo (Tisue & Wilensky, 2004) and Python-based MESA (Kazil et al., 2020) are free, open-source, come with example models, are customizable, and are extensible. Instruction Design (ID) and tutorials involving ABMS exist but have been scarce, as pointed out by Kasaie & Kelton (2015), whose work will serve as one of the frameworks and guidelines (including discretion) for developing the simulator of this study. Feinstein & Cannon (2002) propose an evaluation framework for entrepreneurship simulations with three criteria: *fidelity* (realism), *verification* (operates as intended), and *validity* (the model and the natural world reach the same conclusions). This study aims to fill the gaps in work on the following: 1) customizing ABMS software to support additional entrepreneurial concepts, 2) extending the model to illustrate competition, 3) integrating these ABMS platforms with LMS for educational data mining (EDM), 4) using LLMs for CITS, and 5) sustaining interest in entrepreneurship through CITS and simulation.

3. Research and Implementation Method

The target concept for the back-end simulator illustration is the theory of diffusion of innovation. The agent model parameters are based on the work of Schramm et al. (2010) and simplified rules from Bass (1980). Text related to concepts of diffusion of innovation shall be fed as a knowledge base into the Python-based framework LangChain (Chase, 2022) to prepare the LLM conversational environment through a form of prompt engineering. The CITS will follow existing frameworks for conversational flow while allowing free-flowing conversations with the chatbot, given unforeseen and rare situations. During development, five (5) student volunteers from the B.S. Information Technology Entrepreneurship (BS ITE) program in the Ateneo de Manila University (Philippines) will use and provide feedback iteratively. At least 10 student technology startup groups from BS ITE, each with an average of five (5) co-founders, are expected to volunteer to try the simulator environment. At least one person per startup group is expected to participate. Each volunteer will be randomly assigned to the non-conversational or conversational simulator environment. Participants may follow this general path: 1) Complete a pre-session survey including questions about the student's background, interests, and previous entrepreneurship experience, with additional questions on the learning experience (ex., outcomes, sentiments); 2) Engage with the simulation environment to learn concepts related to technology entrepreneurship. 3) Complete a post-session survey to provide feedback on experience and understanding of the concepts taught in the simulation. Students will have reflection papers at the start, middle, and end of the semester, with only the volunteers answering questions on their experience with the CITS, indicating interest levels before and after the sessions, and submitting their insights through the LMS, after which EDM will be done. The study will take at least two cycles, with additional ones enhanced based on new insights. Early prototypes will use NetLogo and then migrate to MESA. Before roll-out, at least two domain experts knowledgeable in diffusion of innovations will provide feedback based on fidelity and validity.

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