RA Opportunity

If you are interested to contribute in this project as a Research Assistant,

please send your CV and Transcript to erick.purwanto@xjtlu.edu.cn

Basic Information			
Project Title	CodeQuest: Crafting Code with AI Visualizer and Educational Game		
Project Proposed Start Date	01/Sep/2024	**Project Proposed End Date**	31/Aug/2027

Abstract

Traditional teaching methods often struggle to engage a diverse range of learners and effectively convey complex programming or algorithmic concepts. This project aims to address these challenges by integrating coding concepts and exercises into a game environment, supplemented by personalized guidance from an AI chatbot. Additionally, the approach facilitates the visualization of algorithmic steps, making abstract concepts more comprehensible. Learners benefit from tailored support, promoting autonomy and self-directed learning. Furthermore, accessibility is improved through web-based access and the multilanguage capability. While educational games have been shown to enhance learning motivation and personalize the learning experience, there remains a research gap in effectively implementing AI chatbots to provide personalized support. This project seeks to fill this gap by combining game-based learning with AI-driven tutoring, where players embark on coding quests. Leveraging chatbot capabilities, the project promotes individualized learning experiences, fosters active engagement, and enhances understanding of programming concepts and metacognitive skills.

1. Background

Traditional pedagogical methods frequently encounter difficulty in captivating a broad spectrum of learners and effectively communicating abstract programming or algorithm concepts [1]. By embedding coding exercises and quests into a game environment, coupled with personalized guidance from a chatbot, the project addresses these challenges head-on.

Our approach also facilitates the visualization of algorithmic processes, thereby making abstract concepts more tangible [2]. Learners benefit from personalized support tailored to their individual needs and learning pace, fostering autonomy and self-directed learning. Moreover, the flexibility of web-based access and chatbot's ability to switching languages easily ensures accessibility to coding education regardless of geographical location or language.

Research has shown that educational game can stimulate learning motivation, personalize learning experience, and create a safe environment of learning [3]. However, there is still a research gap in understanding the efficacy of integrating AI chatbots into educational games to provide personalized guidance and support to

learners, such as in Megaworld [4]. Thus, this project aims to address this gap by exploring the benefits of combining game-based learning with AI-driven tutoring where players embark on quests to learn coding.

Aligned with student-centered learning, this project leverages chatbot advantages such as offering personalized learning through adaptive feedback [5] and fostering individualized educational experiences [6]. By promoting active engagement, the chatbot encourages hands-on problem-solving, while empowering students to regulate their learning process, nurturing independence [7]. Consequently, the chatbot-powered system can improve understanding of programming concepts, enhance metacognitive skills through reflection, and increase emotional and behavioral engagement [5, 8].

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[5] Liang, H. Y., Hwang, G. J., Hsu, T. Y., & Yeh, J. Y. (2024). Effect of an AI-based chatbot on students' learning performance in alternate reality game-based museum learning. British Journal of Educational Technology.

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[8] Hew, K. F., Huang, W., Du, J., & Jia, C. (2023). Using chatbots to support student goal setting and social presence in fully online activities: learner engagement and perceptions. Journal of Computing in Higher Education, 35(1), 40-68.

2. Aims and Objectives

1. Develop a chatbot capable of visualizing algorithmic steps to enhance comprehension of abstract programming concepts.
2. Implement coding learning quests within an educational game environment.
3. Integrate an AI chatbot as a Non-Player Character (NPC) within the educational game, capable of supporting learners in completing quests and promoting active engagement and self-directed learning.
4. Establish a comprehensive understanding of the impact of combining game-based learning with AI-driven tutoring on student engagement and learning outcomes in programming education.
5. Investigate the effects of the chatbot on enhancing learning motivation, improving problem-solving skills, and increasing understanding of programming concepts among learners.

3. Approaches and Methodology

Stage 1 - Chatbot Development and Algorithm Visualization: Initially, we will focus on developing a chatbot capable of visualizing algorithmic steps to enhance comprehension of abstract programming concepts. This involves designing algorithms for visual representation and integrating the chatbot into a website.

Stage 2 - Coding Learning Quest Implementation: In this stage, we will implement coding learning quests within an educational game environment. These quests will be designed to cover various programming concepts and challenges, providing an interactive and engaging learning experience for the players.

Stage 3 - AI Chatbot Integration as NPC: The next step involves integrating the AI chatbot as an NPC within the educational game. The chatbot will act as a guide and support system for learners, assisting them in completing quests and promoting active engagement and self-directed learning.

Stage 4 - Comprehensive Assessment and Iterative Improvement: We will conduct a comprehensive assessment to understand the impact of combining game-based learning with AI-driven tutoring on student engagement and learning outcomes in programming education. This will involve analyzing data collected from the game environment, such as player interactions and learning progress.

Stage 5 - Dissemination of Results and Best Practices: In this final stage, we will disseminate the findings and best practices derived from the project. This will involve publishing research papers in academic journals, presenting findings at conferences, and creating educational resources and guides based on the project's outcomes. Additionally, we will engage with the broader education community through workshops, webinars, and online platforms.

4. Work Plan and Timeline
Year 1: Month 1: Advertise and recruit research assistants with skills in programming, AI, and educational technology. Months 2-3: Review existing literature on game-based learning and AI-driven tutoring; and establish connections with researchers in educational game with operational platforms. Months 4-7: Analyze existing educational game platforms to understand design principles and features. Months 5-10: Develop a pilot website employing an AI chatbot with visualization capability. Months 9-12: Conduct testing in 1-2 programming classes. Year 2: Months 1-4: Develop general techniques for visualizing programming concepts and integrate them into website. Months 4-10: Design and implement coding learning quests within the educational game platform. Months 5-8: Write a conference paper on chatbot-powered website. Months 6-10: Conduct testing in 1-2 programming classes. Months 7-12: Start a pilot implementation of chatbot as an NMC within an educational game platform. Months 9-12: Write a conference paper on programming quests.

Year 3:

Month 1-6: Integrate the chatbot as an NPC within the educational game platform, implementing features for personalized guidance and support.

Months 3-9: Conduct testing and data collection on programming courses, gathering data on student interactions and outcomes.

Months 6-12: Write a journal paper related to the chatbot-powered website and educational game.

5. Expected Project Outcomes and Deliverables, and Potential for Future Development

Expected Project Outcomes and Deliverables:

- Development of an innovative chatbot capable of visualizing algorithmic steps to enhance understanding of abstract programming concepts.
- Implementation of interactive coding learning quests within an educational game environment, fostering engaging and immersive learning experiences.
- Integration of an AI chatbot as an NPC within the educational game, providing personalized guidance and support to learners.
- Comprehensive assessment of the impact of game-based learning coupled with AI-driven tutoring on student engagement and learning outcomes in programming education.
- Dissemination of research findings through conference papers, journal publications, and educational resources to contribute to the advancement of educational practices.

Potential for Future Development:

- Further refinement and enhancement of the chatbot's functionalities to cater to evolving educational needs and technological advancements.
- Expansion of the educational game platform to cover additional programming topics and cater to diverse learner preferences and levels.
- Integration of advanced AI capabilities to provide more adaptive and personalized learning experiences.
- Collaboration with educational institutions and industry partners to scale up the implementation of the project's findings and best practices.
- Exploration of interdisciplinary applications in other fields beyond programming education to maximize the impact and reach of the developed tools and methodologies.

6. Potential Value

By integrating coding exercises into an immersive game environment and providing personalized guidance through an AI chatbot, this project has the potential to revolutionize the way abstract programming and algorithm concepts are taught and understood. The visualization of algorithmic processes will not only make complex ideas more accessible but also foster a deeper and more intuitive grasp of these concepts. This approach aligns with the principles of active learning, where students are engaged in the learning process through hands-on experiences and problem-solving activities.

The flexibility of web-based access and multilingual capabilities of the chatbot ensure that high-quality coding education is accessible to a global audience, breaking down geographical and linguistic barriers. This enhances the student experience by providing a diverse and inclusive learning environment.

In terms of research-led teaching, this project will explore the efficacy of AI chatbots in educational games, a relatively uncharted area in the field. The integration of AI chatbots as NPCs within the game will provide a platform for empirical research on personalized learning and learner autonomy. The project's outcomes will contribute to the body of knowledge on innovative teaching methods and their impact on student engagement and learning outcomes.

7. Dissemination of results
Our project outcomes will be disseminated through: 1. Conferences on game-based learning, AI-enhanced learning technology, and programming education such as ACM SIGCSE Technical Symposium on Computer Science Education and IEEE International Conference on Artificial Intelligence in Education. 2. Peer-reviewed journals to publish research papers and contribute to the literature on game-based learning, AI-enhanced learning technology, and programming education. 3. The Annual Learning and Teaching Colloquium, EDU Community of Practice, EDU Continuing Professional Development workshops, EDU’s "Supporting Transnational Education" podcast to share our findings and best practices with colleagues within XJTLU.