**Empowering Experiential Learning: A Hands-On Game Engine Programming Initiative for Engineering majors**

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**Need for project:** Calculus-based introductory physics courses are integral to engineering undergraduate curricula, fostering critical thinking, problem-solving, and abstract reasoning. Courses such as PHYS 1251, 1252, 1211, and 1212 cater to a significant student population (N~1,000 per year), emphasizing the importance of developing creative solutions to complex problems. However, the reliance on traditional textbooks presents a challenge, as the gap between textbook representations and real-world scenarios, compounded by frustration with 2-D illustrations, hinders students' motivation to persist in STEM.

**Innovation - current and future directions:** The PI, actively involved in teaching PHYS 1251, 1252, and 1211, has pioneered significant improvements. Noteworthy innovations include well-aligned, simulation-supported pre-lecture videos that integrate 3-D visuals, enhancing student understanding. These simulations, developed from scratch by high school and undergraduate students, provide valuable opportunities for hands-on real-time programming, as demonstrated in the associated poster[[1]](#footnote-1).

In a new project direction, the PI collaborates with astronomy faculty, Dr. Inseok Song, and the research team to address identified limitations (<https://www.stemin3d.net/>). The project aims to develop a 3-D immersive learning platform and activities, allowing students to model, engage in real-world scenarios, honing problem-solving and decision-making skills across Physics, Astronomy, and STEM disciplines.

**Impacts:** The ongoing [pre-lecture videos](https://www.youtube.com/@nandanaweliweriya-physicsa997/videos) have amassed over 18,000 views, indicating widespread student engagement. Integration with an active learning approach has transformed student preparation and collaboration in problem-solving sessions. Positive feedback on CTL’s MSFEs, course evaluations, peer observations, and published research underscore the success of the course redesign.

In the new project direction, freshman Mechanical Engineering majors are actively contributing, leading simulation programming effort, and demonstrating a 100% approval rate for CURO research assistantships in AY2024. The student group, including Ridwan Haque, Emre Alia, and Ricky Correia, is engaged in hands-on experiential learning and real-time game engine programming projects, planning to present their work at the upcoming CURO symposium.

**Project Scope:** Our EETI project proposal aims to impact student learning in introductory physics and astronomy courses by recruiting students from over a thousand engineering majors annually. Students will contribute to the creation of the proposed 3-D immersive learning platform and related activities. By providing an experiential learning environment to students, we promote student success. Students feel free to ask questions and engage with faculty members and other student members. Beyond being an exceptional experiential learning opportunity, the project invites students to engage in education research, measuring the impact of the developed course material through implementation, data collection, analysis, and presentations at conferences.

To thoroughly assess the effectiveness of our 3-D immersive platform and associated activities, we have outlined a comprehensive plan. This involves measuring students' understanding through pre and post test scores, utilizing established standardized tests for physics and astronomy. Additionally, we will collect user feedback, assess user engagement, conduct peer observations, compare outcomes with other instructional methods, and evaluate technical performance. This multifaceted assessment strategy aims to provide a robust understanding of the platform's impact on learning and engagement.

**Funding Request:** Building on prior support from CTL's Learning Technologies Grants and the infrastructure developments crafted with Kyle Jonsen from UGA's engineering department, this proposal seeks ongoing support for the project's advancement. The requested funding of $4000 for our project (Track 2) will be strategically allocated to support the development of the 3-D immersive learning platform and associated activities. The primary focus is on financial support undergraduate students’ programming tasks integral to the project's execution ($2500 in total to support engineering undergraduate students at a competitive rate of $12 per hour), each engaging for approximately 6 hours per week. This ensures fair compensation for their valuable contributions. Additionally, we seek $1500 to support the summer salary of the PI during 2024, ensuring dedicated oversight and project continuity.

**Timeline:**

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| **Month/year** | **Objective or Goal** | **Person(s) Responsible♥** |
| 02/24 - 09/24 | **Simulations and Platform development:** Evaluating existing limitations of current 3-D simulations, user engaging activities and developing new versions Fall 2024 courses | NS, IS,  GS & US |
| 08/24 - 12/24 | Implement initial simulations, activities developed for Fall 2024 courses and outreach events | NW, IS, LM, CH GS/US |
| 09/24 - 11/24 | With the initial developments and trial data, Submit collaborative Grant proposals to Unreal Engine: Mega grant | NW, IS, LM, CH, KJ |
| 09/24 - 10/24 | Collaborate with CTL to conduct mid-semester formative evaluations, utilizing the assistance of an education expert from CTL to gather valuable student perspectives. | NW, IS |
| 10/24 - 12/24 | PI convene with the EETI to review progress and implement necessary adjustments for the remainder of the current semester and upcoming semesters. | NW, IS |
| 12/24 - 01/25 | Analyze data from initial trials. Begin work on publication of initial results | NW, IS, LM, CH, GS & US |
| 01/25 - 05/25 | Update and implement existing simulations, activities for spring 2025 courses and outreach events | NW, IS, LM, CH, GS & US |
| 03/25- 04/25 | Present initial findings at APS regional meeting, USG Teaching and Learning Conference, Engineering education conferences (ASEE-SE), UGA CURO | NW, IS,  GS & US |
| **♥** Nandana Weliweriya (NW), Inseok Song (IS), Loris Magnani (LM), Cassandra Hall (CH), Kyle Jonsen (KJ, UGA engineering), Graduate students (GS), and Undergraduate students (US) | | |

**Contribution to EETI's mission and Future Funding Opportunities:** This project not only offers engineering majors enrolled in prerequisite physics courses a unique hands-on programming opportunity but also provides a gateway to diverse research experiences. Beyond the students consuming the 3-D platform and associated activities, those actively involved in its development will witness the collaborative efforts of both physics and engineering faculty, enhancing their undergraduate experience, and potentially boosting motivation and retention rates. Some of them are expected to be involved in the academic presentations (journal papers and/or conference) of the project results. The PI has received three consecutive CTL Learning Technologies Grants by fostering collaborations with engineering faculty in related projects. Looking ahead, future funding opportunities are strategically considered. The National Science Foundation's Education and Human Resources (NSF-EHR) division, particularly through the "Improving Undergraduate STEM Education: Education and Human Resources (IUSE: EHR)" initiative, stands as a primary avenue, offering funding up to $5,000,000 over three years. Additionally, the Unreal Engine Epic MegaGrant presents an exciting alternative, providing support for projects that contribute to the open-source 3D graphics ecosystem, including education initiatives, with grants of up to $500,000. These avenues signify a commitment to sustained project success and expansion.

1. <https://www.researchgate.net/publication/369589001_Integrating_Well-Aligned_Pre-Lecture_Videos_in_Student-Centered_Large_Enrollment_Undergraduate_Physics_Courses> [↑](#footnote-ref-1)