NSF GRANT EMPOWERS SMU RESEARCHERS TO OPTIMIZE GAMING PLATFORM FOR TEACHING STEM+C

According to the National Science Foundation (NSF), an innovative and well-educated STEM+C (computing) labor pool is crucial to the nation's prosperity, security and competitiveness. Ideally, preparation begins in pre-K and extends through Grade 12. NSF believes that students should learn not only the science and mathematics competencies but also how computational thinking is integral to all STEM disciplines.

Always on the lookout for innovative NSF funding opportunities, Leanne Ketterlin-Geller, professor and Texas Instruments Endowed Chair in Education and director of research in mathematics education at the Simmons School of Education & Human Development, saw an opening for STEM+C-based curriculum funded research and knew exactly who to recruit for an interdisciplinary team. Eric Larson, associate professor in Computer Science at Lyle, was the first person she contacted because of his expertise in utilizing machine learning to evaluate human-computer interaction, automated assessment and modeling. In turn, Larson knew the research team needed educational gaming expert Corey Clark, deputy director of research at SMU Guildhall and assistant professor of Computer Science at Lyle.

With Clark's gaming background, the professors were in a prime position to respond to NSF's call. In a similar, recent award-winning project, Clark worked with SMU educators, designers and Literacy Instruction for Texas (LIFT) to create an Indiana Jones-like game to help adults improve reading comprehension through the popular video game, Minecraft. That project was selected as a grand prize winner in the Barbara Bush Foundation Adult Literacy XPRIZE competition. In addition, the project received an achievement award for the most effective app to help adult English language learners learn how to read.

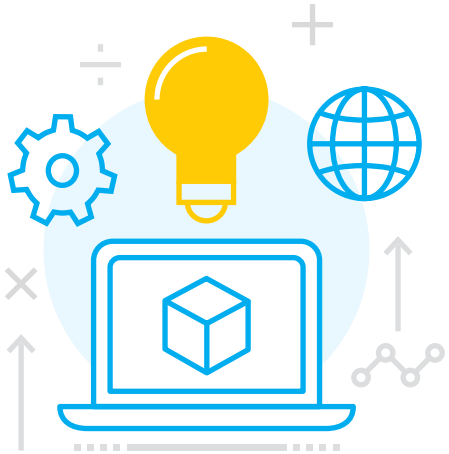
When Ketterlin-Geller and her research team initially discussed the project, they realized the technology behind the XPRIZE award-winning game could be optimized for teaching STEM+C. "We figured if educational gaming can help teach literacy concepts, why not use it to teach math, science and computational thinking by converting it into Minecraft?" Clark says. "Because this game platform is already built around the idea of the progression of technology, we wanted to capitalize on and make that progression connected to real educational concepts."

With a goal of teaching STEM+C concepts through video gaming in mind, the team collaborated on a proposal and was awarded funding from NSF (Award #DRL-1933848) to research the fields of game design, human-computer interaction, machine learning, curriculum design and education assessment by integrating STEM+C-based curriculum directly into Minecraft. The project is looking at ways to help advance knowledge in game-based learning by building on techniques and experiences from commercial game design. The game and infrastructure produced through the research will serve as a vital computing resource for middle and high school educators. Research began last fall and will continue through 2022.

The research team operates out of facilities in three separate locations; Guildhall, Lyle and Simmons, with plans to move into the new Gerald J. Ford Hall for Research and Innovation, where the Guildhall will be housed later this year. The researchers are busy recruiting additional members to join the project, including graduate and undergraduate students.

Elizabeth Adams, STEM Evaluation Researcher at Simmons, also recently joined the team. Adams' skillset in student assessment and modeling will complement Larson's research role in the project. Much of Larson's research focuses on using machine learning to help assess students in a learning environment. In previous work, his lab used biometrics sensors and profiles of touch interactions from students to help predict their performance on various learning tasks. "For this project, it's natural to ask if similar student assessments can be achieved using machine learning to monitor the types of interactions in the Minecraft environment," Larson says. "Our research will create machine learning models that use student gameplay to automatically map to certain performance in the game and also from a wider perspective, for learning computational thinking in general."

The team is also working with the Minecraft Education unit and is talking to local school districts about possible collaborations. "We hope to have students and teachers as participatory research subjects, which is important because often educational initiatives are designed with some level of assumptions about teacher practices or student engagement," Ketterlin-Geller says. "It's also a huge benefit that students are already comfortable with the Minecraft platform. Having student and teacher voices in the ultimate design and dissemination of the project will help with its implementation, longevity and sustainability."



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Deputy Director of Research at SMU Guildhall and Assistant Professor of Computer Science at Lyle

Ketterlin-Geller notes that research has proven the faster classroom technology is adopted by students, the greater the probability of success in the classroom. The SMU interdisciplinary research team will take the technology a step further by incorporating the existing back-end operating code from the XPRIZE literacy project and integrating the technology directly into a learning management system like Canvas. "That way, teachers aren't actually navigating Minecraft, but a system they already use," Clark explains. As backup, professional development for teachers will be wrapped up in the implementation, with training and testing included in the budget. To encourage more local school districts to participate in the program, the researchers envision hosting game testing events on campus.

Through the project, the research team aims to create a more stable, ethical and inclusive data science workforce by broadening interest in data science to a more diverse population of PK-12 students. "We're presented with the challenge of finding creative ways to positively impact student outcomes in STEM and the value it can provide in the learning experience," Ketterlin-Geller says. "We struggle with PK-12 student engagement in math and science, so this project is an optimal way to help us generate new interest while meeting our education goals and seeing students succeed and excel in these fields."

Clark believes incorporating the Minecraft education-based platform will help engage and retain students in STEM+C throughout their PK-12 education and propel them toward careers in related fields. "A key initiative of STEM+C is to cultivate the skills for the next generation of data scientists, information scientists and engineers," says Clark. "Video games are developed around fundamental activities, or gameplay atoms, which reflect the experiential learning process through a trial and error in-game conveyance/feedback loop. They provide a technique to engage students in a fun and intuitive manner."

Larson agrees, and is confident that the research carried out at SMU will have a long-lasting impact on learning, assessment and fostering of STEM+C standards for students before they reach college. "It's an incredibly important skill for today's professionals to be able to speak in code, regardless of their chosen profession," he adds. "As computing makes its way into the vernacular of arts, business and sociology — not just in traditional STEM fields — it's important that we prepare students properly, through avenues that increase their interest in computing in general so the change is sustainable for future generations. Video games might provide a useful mechanism for achieving this goal."

To make this learning platform relevant across the U.S., the research team is integrating curriculum that aligns with education standards such as Common Core Standards in Mathematics (CCSS-M), Next Generation Science Standards (NGSS-2013), Computer Science Teachers Association (CSTA-2017), and California Computer Science Content Standards (CACS-CS 2019) into successful loops found in Minecraft. These loops contain game mechanics that have shown to engage a broad demographic of players across age, gender, race and socioeconomic factors.

Ultimately, the SMU research team is striving to achieve some key student outcomes. These include engaging in gameplay; changes in students' interest, attitudes, beliefs and self-efficacy in STEM+C; involvement in collaborative, open-ended solutions; and achievement in related computing and mathematics concepts. Feedback from teachers and students will help refine and expand the game platform to evolve along with the technology.

Ketterlin-Geller stresses that the development of this educational platform is not a one and done. "We're not trying to study this and file away a research paper. This learning tool is something that will be kept fresh and relevant, so teachers can put it into place in their practice for years to come." ■

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