ITEST

Innovative Technology Experiences
for Students and Teachers

PROJECT SUMMARIES

2024

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STEM LEARNING AND RESEARCH CENTER

NATIONAL SCIENCE FOUNDATION

ITEST Project Summary Booklet

The one-page project summaries included in this booklet provide an overview of ITEST project work "on the ground" and how that work addresses each of the ITEST program's pillars: 1) Innovative Use of Technologies in Learning and Teaching, 2) Partnerships for Career and Workforce Preparation, and 3) Strategies for Equity in STEM Education. The booklet is organized into grade spans to align with PI meeting working groups. As you participate in the 2024 ITEST Principal Investigator's meeting use this booklet to become better acquainted with ITEST and the work of your ITEST colleagues.

About the ITEST Program

The economic prosperity and national security of the United States is reliant upon the nation's capacity to remain globally competitive in the technological and computational fields. The nation's competitiveness, however, is contingent upon its capacity to educate the next generation. Learning and teaching must be reimagined to better represent the diverse composition and perspective of our nation's people and be expanded to encompass all pathways for students to receive a high-quality STEM education. A highly proficient and diverse technological and computational STEM workforce is needed to advance new discoveries in science, engineering, and technology in the service of the nation. ITEST responds to this challenge and opportunity by aiming to provide all students with equitable access to a STEM education related to the technical and scientific workforce.

ITEST is an applied research and development program with goals to advance the equitable and inclusive integration of technology in the learning and teaching of science, technology, engineering, or mathematics (STEM) from pre-kindergarten through high school. The program's objective is to support all students' acquisition of the foundational preparation in STEM disciplines. Preparation for the current and future workforce is increasingly dependent upon the application and use of technology and computing.

ITEST projects (1) engage students in technology-rich learning to develop disciplinary and/or transdisciplinary STEM content knowledge, including skills in data literacy and evidence-based decision-making and reasoning; (2) prioritize the full inclusion of groups who have been underrepresented and/or underserved, including but not limited to Blacks and African Americans, Alaska Natives, Hispanics and Latinos, Native Americans, Native Hawaiians, Native Pacific Islanders, persons with disabilities, neurodiverse students, and women in the STEM and information and communication technologies (ICT) workforce; (3) motivate students to pursue appropriate education pathways to technology-rich careers; and (4) leverage strategic and community partnerships to expand education pathways in communities through public and private partnerships and collaborations.

ITEST is a program of the Division of Research on Learning in Formal and Informal Settings, Directorate for STEM Education, National Science Foundation, 2415 Eisenhower Avenue, Alexandria, VA 22314

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3D models for learning Plant Science

The NSF ITEST project has been a concerted effort towards integrating STEM education with art and design (STEAM) to kindle interest in plant sciences and promote career readiness in high-tech agriculture. Over the reporting year, the project engaged 108 students from six high schools, implementing a teaching module that involves collaborative teams working on plant science investigation, 3D modeling, and its applications in Augmented Virtual Reality (AVR) platforms and science communication. Another 300 participants benefitted from field trips and other outreach events with plant-tech exposure. Goals & Accomplishments The project aimed to: • Inspire STEM career interests. • Enhance knowledge and appreciation of plant science. • Integrate art and design into STEM education. • Advance plant science education through 3D modeling and AVR. Accomplishments include successfully implementing the teaching module at six high schools, including rural schools, notable outreach events, and field trips that provided immersive AVR experiences. The project reported positive impacts on student interests in STEM careers and significant gains in STEAM-related knowledge and skills.

Target Gradespan(s): High school (9-12)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Life sciences
Geographic Location(s): Rural

Related Links: (https://www.danforthcenter.org/our-work/education-outreach/education-technology-program/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Key activities featured virtual and in-person engagements with students, educators, and scientists, hands-on experiences with 3D modeling and AVR technologies, and exposure to real-world plant science applications. Events such as PlantTech Jam, Party with the Plants, and partnerships with local and regional educational bodies augmented the project's reach.

Pillar 2: Partnerships for Career and Workforce Preparation.
Professional development workshops were conducted, enhancing educators' capacity to implement AVR and 3D modeling in their curriculum and fostering an enriched learning environment.

Pillar 3: Strategies for Equity in STEM Education
The project has significantly impacted educational practices by introducing novel methods and interdisciplinary approaches. Rural high school participation, promoting diversity in STEM fields, and enriching STEAM education content and experiences stood out as prime achievements.

Related ITEST Project:
Students Build Augmented and Virtual Reality Plant Models to Understand the Role of Design in STEM (Award# 1949463)

Principal Investigator(s):
Kristine Callis-Duehl (kcallis-duehl@danforthcenter.org)

Co-Principal Investigator(s):
Sandra Arango-Caro, Christopher Topp

3D Printing and Astronomy for High School Students with Blindness/Visual Impairments and their Educators

3D printing holds promise for students with blindness/visual impairments (B/VI) in addressing astronomy content, concept development, and providing access to information normally displayed visually. To help bolster astronomy and STEM opportunities for students with B/VI, we developed the STEM Career Exploration Lab (CEL), which employs tactile astronomy instruction via 3D printing and specially designed 3D-printed models. Our unique project centerpiece is the 3D printer build, where students with B/VI assemble and use desktop 3D printers. By the end of 2024, we will have held 18 week-long STEM CEL summer camps in 12 states, 3 in each of the 4 main US census regions. We collaborated with Teachers of the Visually Impaired and general education STEM teachers via annual Educator Partner Institutes (EPIs) to develop our astronomy lessons and 3D models. These educators also assist with the STEM CEL summer camps. Thirty-three teachers from 11 states have participated. We gathered pre- and post-intervention data via surveys, astronomy assessments, and interviews, resulting in what is likely the largest research study on astronomy and 3D printing instruction for students with B/VI. Once fully evaluated and refined, we will make our 3D models and lessons freely available. We find that with appropriate context and guidance, 3D printing is effective in increasing scientific understanding and showcasing scientific data (largely from space telescopes) for appreciation of astronomy and STEM.

Related Links: 3D Astronomy Website, Space Telescope Science Institute (https://www.stsci.edu/~carolc/3dastronomy/3D-Astronomy.html),Ohio State News Article about Educator Partner Institute Held February 2023 (https://news.osu.edu/ohio-state-hosts-stem-institute-for-teachers-of-students-with-visual-impairments/),You Can Do Astronomy, LLC (https://youcandoastronomy.com),Tactile Universe Project (https://tactileuniverse.org/),NASA 3D Printable Models (https://nasa3d.arc.nasa.gov/models),International Astronomical Union Resources for those with Blindness/Visual Impairments (http://sion.frm.utn.edu.ar/iau-inclusion/?page_id=75),International Astronomical Union Conference Proceedings Paper Summarizing the Career Exploration Lab (https://www.astroscu.unam.mx/rmaa/RMxAC..54/PDF/RMxAC..54_TMadura-XV.pdf)

Target Gradespan(s): High school (9-12) , Post-secondary
Project Category: Developing and Testing Innovations (DTI) , Research Study
Discipline(s): Engineering , Physics and astronomy , Other
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Our project centerpiece is the 3D printer build, where high school students with B/VI assemble and use desktop 3D printers. Our STEM CEL lessons focus on spatial thinking and employ tactile 3D printed models, other tactile materials, sound and kinesthetic activities to teach astronomy and STEM. The backbone of our program is engagement with Teachers of the Visually Impaired and High School STEM teachers via Educator Partner Institutes, where we work together to address barriers to success in STEM of students with B/VI.

Pillar 2: Partnerships for Career and Workforce Preparation.
We introduce high school students with B/VI to professional role models with B/VI who have successful STEM careers. We also incorporate field trips to local businesses and universities that afford insights into possible STEM careers.

Pillar 3: Strategies for Equity in STEM Education
Students with B/VI often have other disabilities that also need to be accommodated when teaching STEM. Students with B/VI also often do not have the same life experiences and background knowledge as their sighted peers. There is a dearth of resources in STEM for students with B/VI, so most STEM materials must be developed from scratch and a wide range of materials is needed, e.g. tactile models (2D & 3D), braille, large print, audio, etc. 3D printed models can work, but often not by themselves.

Related ITEST Project:
Career Exploration Lab: 3D Printing and STEM Engagement for High School Students with Visual Impairments and their Educators (Award# 1949458)

Principal Investigator(s):
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Co-Principal Investigator(s):
Tiffany Wild, Carol Christian

Adapting QISE technology for use in the high school classroom

The objectives of the project include:1) increase STEM and ICT career awareness by providing opportunities for teachers and students to learn about how STEM content disciplines can fully integrate technology and engineering, 2) provide professional development for STEM teachers to learn about quantum related topics and effective curricular connections, 3) provide student summer STEM camps to engage students in technology-rich STEM/QIS experiences, and 4) research a new professional development (PD) model designed to increase positive teacher and student experiences with ICT, STEM, and QIS in a manner that promotes student knowledge and interest in pursuing future STEM careers in an appropriate amount of time. The PD model for this project provides opportunities for high school STEM teachers to learn about quantum concepts utilizing a unique trainer of trainer approach where the teacher PD is tied to a summer camp experience. During the camp teachers can test their delivery of the material with students in the summer camp with the hope of increasing implementation in the classroom. Curriculum and resources used are designed to be pedagogically appropriate, easily implemented, and require little equipment. The project aims to impact a minimum of 100 teachers and 600 students.

Target Gradespan(s): High school (9-12)
Discipline(s): Interdisciplinary

Related Links: (https://quantumforall.org/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
High school classrooms generally do not have equipment to teach quantum information science. Therefore, we have partnered with experts to develop “scaled down” technology representative of what is used in industry or research. Two examples include: 1) Michelson Interferometer demonstrates how LIGO can detect gravitational waves through the use of interference patterns of light and 2) quantum key distribution (QKD) demo which allows students to perform a simple version of the QKD protocol using polarized light, teaching

Pillar 2: Partnerships for Career and Workforce Preparation.
Current technology requires an understanding of quantum information science (QISE). Although educators may recognize the importance of helping students learn about future QISE careers, they are often overwhelmed as to how to teach these concepts. This project provides support for educators willing to help students learn about quantum career opportunities, thereby increasing the quantum workforce pipeline. In addition to teacher PD, the project provides student camps and creates opportunities for student families to

Pillar 3: Strategies for Equity in STEM Education
Knowledge regarding quantum information science (QISE) and associated career opportunities needs to begin in grades K-12. A logical venue for exposure to quantum concepts might be a physics course, but numerous schools do not even offer physics. This project provides opportunities for K-12 students to recognize the relevance of quantum in their everyday lives and increase QISE career awareness. Results of the project will potentially inform other PD models to serv underrepresented groups and reduce potential barriers r

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Related ITEST Project:
Preparing Secondary Teachers and Students for Quantum Information Science (Award# 2048691)

Principal Investigator(s):
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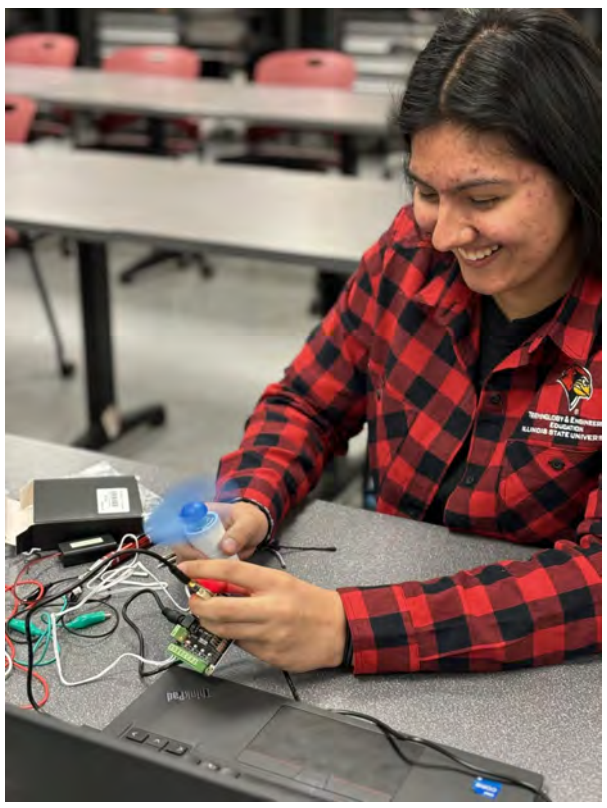
After-school programming SUPERCHARGE(d)

SUPERCHARGE is an after-school STEM program wrapping up its first year in four Chicago high schools. The goal of SUPERCHARGE is to give students experiences with STEM, specifically with robotics, automation, and green energies, that build their interest and confidence. Students attend the club for 90 minutes each week where they work through sets of activities that build skills with connections to green energies and environmental justice. Activity sets culminate in an authentic project each spring where students build a project that lets them explore a facet of the environmental landscape of their communities and the world more broadly. Faculty in the Department of Technology and the College of Education at Illinois State University collaborate with teachers and four community-based organizations from across the city of Chicago in this project. The purpose of those collaborations are to design activities that give students authentic experiences that are culturally sustaining. Teachers in SUPERCHARGE are each full-time faculty in the schools where the clubs take place. As facilitators, they learn alongside the students and position students as problem solvers. The design of units of activities each year are reflective of students' communities and intended to help situate them as community members with skills and expertise and who understand sustainability challenges and solutions more deeply.



Related Links: Club Activities (https://sites.google.com/d/15Hb19yMeQTPiPQMavpmolUda3hcwKjKT/p/1YzOBi-hz6H0UZFVsUyMR0RQnFuvUEnOm/edit?pli=1)

Target Gradespan(s): High school (9-12)
Project Category: Youth-Based
Discipline(s): Computer and informational technology science , Engineering , Environmental sciences
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Club time involves progressively more challenging experiences using micro:bit, which is a programmable device developed for students to have access to coding and digital applications. As students engage from more simple activities to those involving expansion and control boards, their skills for programming and electronics, for purposes tied to green energy, deepen. During the first year the culminating project is a weather station built and programmed by SUPERCHARGERS. Summer workshops further develop applications.

Pillar 2: Partnerships for Career and Workforce Preparation.
The supports and design of activities center access to STEM among high school participants. Campus visits and workshops that include STEM professionals and businesses are a part of each years SUPERCHARGE programming.Of the small number of high school seniors who participated in SUPERCHARGE during its inaugural year, at least one chose a major in computer science at Illinois State University and credited the program and campus visit for that choice.

Pillar 3: Strategies for Equity in STEM Education
Each year the PI and co-PIs work with a team of undergraduate STEM majors to develop and pilot each SUPERCHARGE activity. The undergraduate students are selected among applicants for their commitment to equity, their interest in engineering technology and sustainable energy. The serve as resources for clubs when questions arise and as models of what is possible for the high school students as they consider their own futures in STEM. This project also supports the disruption of deficit thinking among STEM professionals.

Related ITEST Project:
STEM-based University Pathway Encouraging Relationships with Chicago High schools in Automation, Robotics and Green Energy (Award# 2148429)

Principal Investigator(s):
Matthew Aldeman (maldema@IllinoisState.edu)

Co-Principal Investigator(s):
Allison Antink-Meyer

An AI Elective for Georgia Middle School Students

“Living and Working with Artificial Intelligence” is a 9-week elective course for Georgia middle school students co-designed by the investigators and a cohort of six teachers. We created the course and professional development materials to study student and teacher AI learning. For students, we are interested in the most effective ways to promote interest in AI and robotics among different demographic groups who are underrepresented in STEM: rural white students, urban black students, and suburban Latino students. For teachers, we want to understand what kind of training and support teachers need to feel confident about teaching AI. Over the past three years we have trained 20 teachers and piloted the course with over 1500 students. Three units have been implemented: (1) Autonomous Robots and Self-Driving Vehicles, (2) How Computers Understand Language, and (3) Machine Learning and Automated Decision Making. Drafts of our course materials are available on the AI4GA.org website. Research findings: Middle school students can engage with AI concepts such as semantic feature spaces, decision tree classifiers, and linear threshold units when presented with sufficient scaffolding. They have strong preferences for activity-based learning and choice of projects. It takes approximately 1.5 years of training and practice for CS middle school teachers to become comfortable teaching AI content. Curriculum should accommodate different teaching styles: teacher-led vs student driven.

Related Links: AI4GA.org Project Web Site (https://AI4GA.org)

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Students use a variety of online demos to gain hands-on experience with AI algorithms. Examples include Teachable Machine, Machine Learning for Kids, speech recognition demos, face recognition demos, Neuron Sandbox, AI extensions to Scratch, and the Calypso robot intelligence framework.

Pillar 2: Partnerships for Career and Workforce Preparation.
The curriculum provided opportunities for students to learn skills vital to AI-enable careers such as training a classifier, designing a robot, working with tabular datasets, and analyzing impacts of AI. The curriculum also featured applications of AI in different sectors of society and highlighted AI professionals and careers through videos and career cards. Several teachers created projects where students investigated the impacts of AI on industries in their county or explored the impact of AI on their chosen field.

Pillar 3: Strategies for Equity in STEM Education
The project intentionally recruited teachers and students from geographically and ethnically diverse populations to ensure that all students in Georgia had the opportunity to learn AI. We worked with rural, suburban, and urban districts to achieve this demographic diversity. Our curriculum allows teachers to choose from a variety of activities and adapt them to their teaching styles and the abilities of their students, including those with low reading levels or no prior programming experience.

Related ITEST Project:
AI4GA - Developing Artificial Intelligence Competencies, Career Awareness, and Interest in Georgia Middle School Teachers and Students (Award# 2049029, 2048502)

Principal Investigator(s):
David Touretzky, Christina Gardner-McCune (dst@cs.cmu.edu)

Asset Based Learning Environments with Dream2B

Model Math Education (ModelME) with embedded Dream2B game is an integrated supplemental curriculum for 4th-6th grade inclusive settings. The program engages students in universally-designed problem-solving challenges rooted in authentic STEM and ICT careers. Executive function scaffolds, action adaptive nudges, and dynamic assessments are embedded throughout the game and the wrap around curriculum. The program has been used by over 15 teachers and 350 elementary and middle school students and their teachers in both rural and urban settings in North Carolina, California, and Florida who are underrepresented in STEM. Pilot testing suggests the capacity of the program to increase engagement in and understanding of fraction concepts along with students' interest in STEM careers. The game is now progressing into a Gold build, which will involve updated narratives, character voices, and introduction. We will also update and finalize the wrap around curriculum package for final dissemination.

Related Links: Game website (https://modelmemath.com/),NC State project website (https://research.ced.ncsu.edu/modelme/)

Target Gradespan(s): Elementary school (K-5) , Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary , Other
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The use of the video game with wrap around curriculum defines learning as both individual and social. The use of the game provides students access to multiple ways of engaging, representing, and expressing knowledge, which sets the stage for students to connect gameplay strategies with others' ways of reasoning as strategies are discussed and connected to the big ideas of fractions.

Pillar 2: Partnerships for Career and Workforce Preparation.
We ensure students obtain the prerequisite knowledge and skills to be successful in middle and high school algebra courses by bolstering fundamental conceptual understanding of fractions, a cornerstone of algebraic thinking. The curriculum and videogame provides students with a virtual coach across five ICT and STEM careers that guide students as they engage in problem solving adventures, educating them in career facts along the way.

Pillar 3: Strategies for Equity in STEM Education
We center disability as an identity – as opposed to the "typical" learner - in our game through the use of Universal Design For Learning, which we tested in inclusive, whole class settings. Students with disabilities' thinking is also centered in the wrap around curriculum. For example, we elevate the diversity and power of students' thinking, whether those strategies are supported with drawings, models, or symbols. This celebrates and represents the diversity of students' experiences and ways of reasoning.

Related ITEST Project:
Enhancing Engagement and Conceptual Understanding of Fractions for Students with Learning Disabilities using the Model Mathematics Education Curriculum (Award# 1949122)

Principal Investigator(s):
Jessica Hunt (jhunt5@ncsu.edu)

Co-Principal Investigator(s):
Matthew Marino, Michelle Taub

Auditing Machine Learning Applications for Algorithmic Justice with Computer Science High School Students and Teachers

Our proposal introduces algorithm auditing to high school computer science classes. Algorithm auditing is a query method for understanding algorithmic systems' opaque inner workings and external impacts from the outside. Sample student projects: (A) Drawing game using a ML classifier trained with accelerometer data; (B) Accelerometer sensor data for training and testing a ML model used in a sports game;

(1) Generate a hypothesis: What biased behavior do you expect to see?	**(2) Generate inputs:** What list of inputs are systematic, thorough, and thoughtful?	**(3) Run the test:** Keep track of the inputs and output pairs	**(4) Analyze data:** Is your hypothesis supported by the data?	**(5) Audit Report:** Share what you found with others (to try and spur change)

May 2024: Teacher Pre-Interviews

Gather:

● What are high school CS teachers' values and considerations of algorithmic justice in machine learning applications?

Summer 2024 Co-Design Workshop: July 8-12, 2024

Participants:

● Six experienced CS teachers: Los Angeles, Delaware, Philadelphia - Equity-driven CS experience with urban, suburban, and rural students - Experienced with electronic textiles & physical computing

● High school students (Philadelphia)

- Experienced in designing algorithm audits
- Novices exploring algorithm audits

Fall 2024

Design:

● Revise & draft Algorithm Audit Curriculum for high school CS classrooms

● Two group meetings

● One-two teachers leading curriculum design

Analyze

● Teacher Pre-Interviews

Spring 2025

Test & Gather

● Pilot curriculum in two classrooms

● How do high school CS teachers integrate and support students' collaborative audits of machine learning applications in classrooms?

Equity:

● Increase AI/ML knowledge, skills, and attitudes of students in economically disadvantaged and racially/ethnically minoritized populations in current STEM education efforts and careers ● Directly reach students in two classrooms (Spring 2025) and six classrooms (Spring 2026) ● Working with teachers in California, Delaware and Pennsylvania school districts. ● Curriculum to reach many more!

Related ITEST Project:

Exploring Theory and Design Principles (ETD): Auditing Machine Learning Applications for Algorithmic Justice with Computer Science High School Students and Teachers (Award# 2342438)

Principal Investigator(s):

Yasmin Kafai (kafai@upenn.edu)

Biology Meets Engineering: Students Exploring the Connections Between Animals and Robots

Biology Meets Engineering provides transdisciplinary education to prepare students for a future in STEM. We have developed and hosted a 3-week summer program on campus, through which high school students in and around Cincinnati have applied the fundamentals of sensory biology, robotics, and computer programming. An undergraduate course expands upon knowledge gained in the summer, and we provide paid internship experiences in university STEM labs. We developed a curriculum that integrates students' learning of sensory biology and, respectively, robotics, to create experiences that reflect modern approaches to scientific practice and research. For example, students learn about bats' use of sonar and apply those mechanisms to develop robots that respond to sonar. Professional development has enabled local teachers to use the curriculum in high school science courses. Students' participation in transdisciplinary tasks has facilitated their use of science and engineering practices, especially those related to computational thinking. Students have shown improved perceptions of STEM, especially with respect to collaborative problem solving. Additionally, we have seen a positive impact on students' motivation and self-efficacy, especially for students in high school settings who begin with lower self-efficacy in these areas. Our next project will document changes in students' motivation and science inquiry in high schools across the state.

Related Links: (https://www.biologymeetsengineering.org/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Biology Meets Engineering creates learning experiences authentic to modern approaches to robotics design. Students in the summer program and in the undergraduate course build robots that incorporate a variety of sensors (e.g., light, sonar, color). They are exposed to the fundamentals of robot control and electronic sensors. Students learn about animal sensory behavior and computer programming, and they apply that knowledge to create robots that autonomously respond to stimuli in the environment.

Pillar 2: Partnerships for Career and Workforce Preparation.
Biology Meets Engineering incorporates an internship experience for students to gain work experience and career preparation through paid positions in biology and engineering research labs in the summer at the University of Cincinnati. Faculty mentors in biological sciences or engineering opened their labs for these research opportunities.

Pillar 3: Strategies for Equity in STEM Education
Biology Meets Engineering has remained committed to recruiting students primarily from urban schools that serve larger percentages of students who are historically underrepresented in STEM compared to suburban schools. We have also prioritized gender parity in the summer program. The project team visited high school courses and built relationships with teachers, guidance counselors, and other school personnel to help recruit interested students. This strategy paid off in the interest we have seen in the program.

Target Gradespan(s): High school (9-12)
Discipline(s): Computer and informational technology science , Life sciences
Geographic Location(s): Urban

Related ITEST Project:
Trans-disciplinary Education in Biology and Engineering Technology (Award# 1759150)

Principal Investigator(s):
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Co-Principal Investigator(s):
Anna DeJarnette

Book Drop: Creating a video series for early learners to engage in literacy, STEM, and careers!

STEM Tales is a 2.5 year research project focused on the creation of a new children's media series (titled Book Drop) which focuses on STEM learning, literacy, and careers. OUTREACH: STEM Tales outreach is designed to engage children (ages 4-8) and families through in-person programming at 21 libraries across the nation. In each library program, families view one episode of Book Drop, learn about the career of the book reader, and engage in hands-on activities that focus on important STEM skills. Families are provided with a copy of the book and a family guide for continuing the STEM learning at home. BOOK DROP SERIES: Episodes feature the reading of a children's book with a STEM focus, complemented by live-action children engaging in STEM activities, and an animated story featuring Kitty & Leo, who travel the Earth (and into space!) delivering books to real-life STEM professionals for story time. STEM professionals act as the storybook readers, and feature careers including astronauts, engineers, zoologists, and gardeners! RESEARCH: While research shows that in-person read-alouds are effective at teaching children literacy skills, little is known about how media read-alouds impact children's literacy skills and academic knowledge, or if they motivate children to future careers. The STEM Tales research project investigates the effect of media read-alouds by diverse scientists and engineers on STEM and literacy in young children and their interest in careers.

Target Gradespan(s): Early Childhood (PK) , Elementary school (K-5)
Discipline(s): Interdisciplinary
Geographic Location(s): Rural , Suburban , Urban

Related Links: (http://www.bookdropactivate.org)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Decades of research show that in-person read-alouds are effective at teaching literacy skills. The STEM Tales project aims to expand on this knowledge by using digital media read-alouds and conducting research on how watching a video of a read-aloud can help children learn specific academic concepts and processes, such as literacy development, science inquiry, or the engineering design process.

Pillar 2: Partnerships for Career and Workforce Preparation.
Children have stereotypical views about what STEM professionals do and know little about STEM careers. Media can have a powerful impact on children's beliefs and perceptions, shaping and reinforcing stereotypes about STEM. Book Drop is designed to disrupt stereotypes by featuring diverse onscreen characters, readers, and near-peer role models doing the work that STEM professionals do. Book drop's diverse cast can demonstrate an opportunity for child viewers to see themselves and their own potential in a STEM career.

Pillar 3: Strategies for Equity in STEM Education
All STEM Tales components are founded on DEI principles. The Book Drop media features kids, adult readers, and animated characters from diverse backgrounds. The chosen books feature a diverse cast of characters, and a diverse group of authors and illustrators. Outreach library locations were chosen based on their ability to serve communities underrepresented in STEM career fields. The librarian training and PD materials included explicit focus on strategies and practices to include underrepresented community members.

Related ITEST Project:
STEM Tales: Investigating the effect of media read-alouds on young children's STEM and literacy learning and interest in STEM careers (Award# 2148023)

Principal Investigator(s):
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Co-Principal Investigator(s):
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Can Data Science be more Human Friendly and Accessible?

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Data Science

The overarching goal of our ITEST project is to create accessible data science tools and curriculum that are legally compliant with the Individuals with Disabilities Education Act (IDEA), Section 504 of the Rehabilitation Act of 1973, and to evaluate these materials with a diverse group of high-school aged student learners. We have created through this work a set of multi-modal data science technologies that were born accessible and have re-imagined what data science could become through first principles. In a sense, our goal is to make all aspects of data science less esoteric, easier to understand, and fully accessible to all of us. To help achieve our goal, we have worked diligently on a problem we call the "Accessible Graphics" problem, which seems to get in the way of many aspects of data science for people with disabilities. For example, students that are blind cannot create their own visualizations or interpret them. Similarly, modern programming tools use rich graphics like drag and drop connectable blocks and manipulable output. We have created modern alternatives on top of our open source accessible graphics technologies, allowing anyone to participate and innovate in data science. We have been pilot testing our technologies with people with disabilities and are conducting a large field study in classrooms across the United States starting in 2024.

Related Links: All materials and tutorials are available on the website for the Quorum Programming Language. (https://quorumlanguage.com/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Data science today lags behind many efforts in programming to make it friendlier to high school students. Naming conventions are arguably esoteric (e.g., Kruskal-Wallis) and user interfaces can be as well (e.g., a terminal in R Studio). We have created programming technologies that automatically generate accessible output, like charts, blocks, or visualizations without human intervention. We have then created a 2-week curriculum and 52 reference tutorials teachers can use to experiment and learn with their students.

Pillar 2: Partnerships for Career and Workforce Preparation.
People with disabilities have significant barriers to participation in high-paying professions like computer or data science. For example, tools for generating charts are often not accessible to users that are blind and the profession of statistics often uses very exact language that may cause everyone anxiety, but that could be especially difficult for those with specific learning disabilities. Our goal is to mitigate these and other barriers that reduce or prevent participation of students with disabilities.

Pillar 3: Strategies for Equity in STEM Education
We have established a series of strategic partnerships helping us think about these broader goals. This includes AccessCSforAll, AccessComputing, Landmark School, the Washington State School for the Blind, RStudio, the ACM Data Science Task Force, and other partners in the disabilities community. We are currently leveraging teacher partnerships throughout the US as part of a larger field study designed to help us identify barriers and improve the approach.

Related ITEST Project:
Creating and testing data science learning tools for secondary students with disabilities (Award# 2048356, 2048394, 2048428, 2048605)

Principal Investigator(s):
Andreas Stefik, Jenna Gorlewicz, Brianna Blaser, Nicholas Giudice (andreas.stefik@unlv.edu)

Co-creating climate futures: Young people as community science leaders

Make games, save the planet" is an Arizona State University program that positions young people as community science leaders who use STEM and media to envision and work toward the future they want to live in. With support from adult team members, participating youth leaders have created an XR game prototype to engage community members in exploring local impacts of climate change and possible futures. The program is organized as an equitable partnership, with young people leading the game development and adult team members supporting their work and studying the impacts of the program. Our youth leaders are also systematically developing and investigating their own questions related to the learning outcomes of their digital narrative. We expect that: 1) by exploring existing futures scenarios for Arizona, youth leaders will increase their understanding of climate science, possible solutions to climate change, and pathways to alternative possible futures; 2) by acting as science communicators, participating youth leaders will strengthen their agency and envision a future self that uses STEM and media to create the future they want to live in; and 3) by leveraging their perspectives as young people and community members, participating youth will create innovative informal STEM learning experiences that promote similar outcomes for participating community members.

Target Gradespan(s): High school (9-12)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Computer and informational technology science , Environmental sciences , Interdisciplinary , Other
Geographic Location(s): Urban

Related Links: Video of young people describing their experience with the program (https://youtu.be/4ORDhIQS1jY)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The team has created an XR game prototype using the Unreal game engine, as well as many other technologies. For example, they have recorded the game narrative in ASU's professional voice recording studio and have created a variety of immersive environments for playtesting using projections, VR headsets, and STEAM decks. They have collaborated with ASU faculty, students, and an outside consultant to achieve their vision.

Pillar 2: Partnerships for Career and Workforce Preparation.
The young people have developed skills in game design, teamwork, and leadership, while also growing their understanding of climate science, science communication, and informal STEM engagement. Over two years, they have gradually taken on greater responsibility and are now empowered to make all key decisions related to their game and engagement activities. They are organized into two main groups, the narrative and design teams, each with a designated leader who manages their work and members who have specific roles.

Pillar 3: Strategies for Equity in STEM Education
Our 12 young people have diverse racial/ethnic and gender identities. Five are Hispanic/Latinx, which is greater than the overall proportion in the metro area. The young people are encouraged to bring their whole selves to the program. For the game, they created characters that draw on their identities and connect with their communities, including main characters who are Hispanic/Latinx and speak in both English and Spanish. The team conducts engagement and playtesting activities in English and Spanish.

Related ITEST Project:
Engaging Latinx Youth in Understanding the Science of Climate Change by Developing Digital Narratives and Games (Award# 2148016)

Principal Investigator(s):
Rae Ostman (rostman@asu.edu)

Coastal TRACERS: Tech-infused Research and Community-based Experiences for middle and high school students

This DTI ITEST project is a research practice partnership (RPP) among teachers, administrators, community business partners and other stakeholders, education researchers, and University of Maine STEM and STEM education faculty. Together, we are developing and refining a model to bring authentic coastal monitoring and research experiences to middle level and high school students in rural coastal Maine communities. Their investigations will be used to inform community policy decisions and strategic planning. Partners are also developing and disseminating modules for use in courses that use marine sciences examples and data including, but not limited to, science, social studies, and mathematics. As part of the project, teachers are building their knowledge and skills and collaboratively developing learning experiences for their students through summer institutes and school-year work sessions. Through these learning experiences, students will develop their research, working closely with community stakeholders, and build their skills in using technology, computing, collaborating, and communicating. They will also become familiar with career pathways in their communities that use technology and computer science. Research is focused on student outcomes related to data literacy skills and interest in STEM careers. We are also investigating the supports and resources necessary for teachers to implement these changes in the classroom.

Related Links: (https://umaine.edu/risecenter/), (https://mainestempartnership.org/)

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Technology use is primarily focused on data collection and analysis methods to support student data literacy skills. Current examples include having students designing and deploying various sensors to collect data characterizing the local bay. This has included designing boats, buoys, and ROVs to support deployment of the sensors. Future technology use will be informed by learning experiences developed by a second cohort of teachers who will be joining the project this summer.

Pillar 2: Partnerships for Career and Workforce Preparation.
We are building a team of career and community partners in the marine industry to inform and establish mentorships, job shadowing, and other interactions with professionals for students, enhancing career readiness and community ties. This team also informs and supports development of learning experiences that reflect industry needs, equipping students with essential skills for these careers. We will pilot different options next academic year to evaluate characteristics of impactful experiences in coastal communities.

Pillar 3: Strategies for Equity in STEM Education
Partner schools are primarily in small, rural, low-income communities, some of which have significant migrant populations. A goal is to enable to teachers to provide locally-relevant learning opportunities connected to community needs in order to engage students. We focus on integration across disciplines and modifications to core courses enabling all students varied entry points to engage in interest-driven research. Effort is also being made to build a diverse career partnership team to serve as role-models.

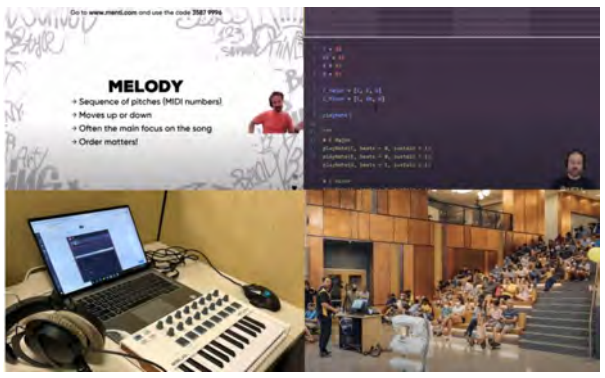
Related ITEST Project:
A Model Program to Engage Students in Authentic, Technology-Infused Coastal Research and Monitoring: Building Student Data Literacy and Career Competency through Partnership (Award# 2148520)

Principal Investigator(s):
Susan Mckay (susan.mckay@maine.edu)

Co-Principal Investigator(s):
Franziska Peterson, Sara Lindsay, David Thomas, Marina Van der Eb

Coding and Creating with Beats

This Developing and Testing Innovations project leverages innovative technology, using professional-quality music software to teach computer science (CS) in a way that is culturally relevant to students under-represented in computing. This project seeks to leverage innovative music technology to facilitate learning of CS. It seeks to accomplish this through 4 inter-related goals and associated objectives: (1) use design-based research to design an instructional approach that highlights how technology tools such as TunePad, scaffolding techniques, and learning activities work to support student learning and interest towards CS across contexts; (2) utilize culturally-relevant pedagogical strategies to increase participating youth knowledge, confidence, interest, and sense of belonging in CS; (3) increase participating youth awareness of CS careers and impacts of computing; and (4) increase youth participation in future CS-related opportunities at school and in informal learning environments. This project designs and conducts both online and in person coding camps for youth to participate, and collects multi-dimensional data to verify achieving the objectives.



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI) , Exploratory , Research Study , Youth-Based
Discipline(s): Computer and informational technology science

Pillar 1: Innovative Use of Technologies in Learning and Teaching
We conducted CodeBeats, which is an innovative educational program focused on computer science (CS) and music. During out-of-school time, youth learned to use coding skills to remix and create realistic-sounding beats. We utilized the NSF-supported software TunePad and created a series of low-floor, high-ceiling scaffolding activities, including both coding and music instruction classes and independent exercises. A culminating event, the Battle of the Beats Competition, was held after the camp.

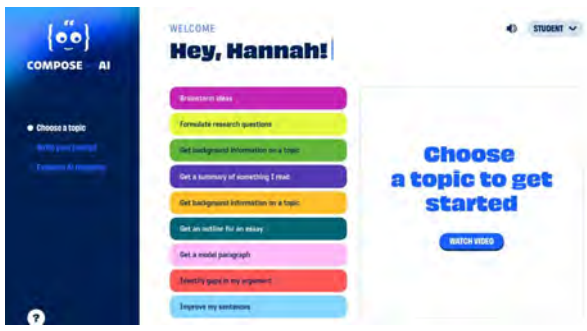
Pillar 2: Partnerships for Career and Workforce Preparation.
During our coding camps, we invited speakers who work in CS (e.g., CS college students, product managers and developers) to talk about their studies and careers. These speakers were not only able to discuss their own careers, but were also able to interact with students, improving their beats both in terms of code and music. During our focus group interviews, we collected students' perspectives on continuing in CS careers and their perceptions about their interactions within the community.

Pillar 3: Strategies for Equity in STEM Education
We utilized hip-hop beats to capture the interest of participating youth from diverse places of origin. We collected both quantitative (i.e., survey) and qualitative data (i.e., focus groups) to examine participating youth CS knowledge, confidence, interest, and sense of belonging in CS. The speakers we invited were also culturally diverse . This work advances hip hop pedagogy by providing many transcribed hip-hop songs (50+) which can be used as a starting point for engaging students in coding.

Related ITEST Project:
Collaborative Research: Minoritized Youth Computer Science Learning, Belonging and Career Interest: Coding and Creating with Beats (Award# 2048793)

Principal Investigator(s):
Chrystalla Mouza (cmouza@udel.edu)

Compose With AI



The purpose of this project is to rapidly develop a web-based platform, called Compose With AI, to address the urgent need for educational tools to support educators in teaching with and about AI. The Compose With AI platform guides students to evaluate AI-generated content and use factual information to compose common types of science-focused writing (e.g., composing arguments, claims or solutions related to science topics). Simultaneously, the Teacher Dashboard shows the process that each student uses to determine for what purpose they want to use AI, how they generate and modify prompts to match their goals, how they evaluate AI content, and how they integrate AI-generated ideas and content with their own ideas. The final result is not just a written essay, but a map of the student's thinking process as they work. The objectives for this one-year project are to: Objective 1: Develop a new digital platform (Compose With AI) to guide students in critically evaluating and ethically integrating content produced by AI into their science-focused writing. Objective 2: Field-test the Compose With AI platform with students in grades 4-8 and their teachers to evaluate the usability and acceptability of the digital platform. Objective 3: Determine which approaches and strategies featured in Compose With AI inhibit and enhance students' abilities to integrate AI-generated content into their writing. Objective 4: Revise and finalize the Compose with AI platform.

Target Gradespan(s): Middle school (6-8)
Project Category: RAPID
Discipline(s): Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Rural , Suburban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
We are designing and developing a platform for evaluating and using AI-generated content.

Pillar 2: Partnerships for Career and Workforce Preparation.
N/A- This is a RAPID project.

Pillar 3: Strategies for Equity in STEM Education
Compose With AI provides opportunities to teach critical evaluation skills for advanced uses of AI and helps teachers integrate AI tools into instruction, which may increase opportunities for all students and lessen the likelihood of a second level digital divide.

Related ITEST Project:
The Development of a Digital Platform for Evaluating and Using AI-Generated Content for Academic Purposes (Award# 2337969)

Principal Investigator(s):
Amy Hutchison (achutchison1@ua.edu)

Computer Science Frontiers

The Computer Science Frontiers (CSF) curriculum created during this project aims to expand access, especially for high school girls, to the most exciting and emerging frontiers of computing, such as machine learning, as well as other 21st century skills required to productively leverage computational methods and tools. The project-based curriculum consists of four 9-week modules: Distributed Computing, Artificial Intelligence/Machine Learning, Cybersecurity/Internet of Things, and Software Engineering. CSF leverages NetsBlox, a powerful yet easy-to-use visual programming environment that has been shown to increase engagement and interest in computing. Additionally, NetsBlox supports effective collaboration while facilitating learning of advanced computing concepts. The curriculum was co-designed with practicing high school teachers and was tested in multiple summer camps. A full year course is currently being piloted in a Nashville public high school for the second year in a row. Our evaluation of student attitudes participating in our programs supports previous research that female students engage well with socially relevant topics like contextually situated AI and Machine Learning. Specifically, our results show a positive increase in female participant confidence and self efficacy in computer science content and career identity.

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Data Science

Related Links: Project Website (https://csfrontiers.org/),NetsBlox website (https://netsblox.org/),Introductory video (https://www.youtube.com/watch?v=uqPOer3aXZg&ab_channel=CSFrontiers),Teacher PD Resource (https://www.coursera.org/learn/programming-for-a-networked-world)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
CSF uses NetsBlox, a block-based programming environment that opens the internet for student programs. It lets them access a rich library of online data sources and services, such as Google Maps, a movie database, science data, etc. They can create social applications like a chatroom or distributed multiplayer games. Student projects can access their phone's sensors turning the phone into an IoT device. Students program virtual robots in a 3D simulated environment collaborating with or competing against each other.

Pillar 2: Partnerships for Career and Workforce Preparation.
CSF has been approved by the TN DoE, so any high school in the state may adopt it. We have worked with 8 teachers from three states who taught various modules or the entire course in camps and in their classrooms. We partnered with the Tennessee STEM Innovation Network tasked by the state to support all public schools with meeting the new high school CS graduation mandate. We partnered with Coursera and published a free 6-week online course aimed as professional development for teachers to prepare them for teaching CSF.

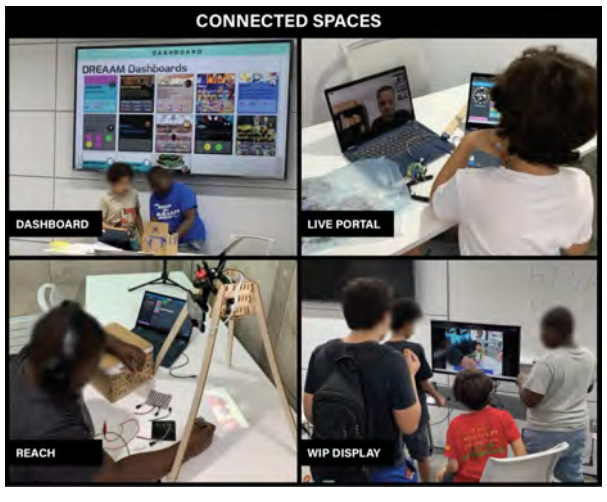
Pillar 3: Strategies for Equity in STEM Education
CSF uses equity-focused pedagogies such as PBL, datasets with personal relevance to students and communities (e.g., climate change, healthcare, and social justice data), opportunities for personalization (through project choices), and engagement with the social implications of computing. The curricular modules have been co-designed with a group of diverse high school teachers and it allows for customization to increase relevance to students' lives, communities, and interests.

Related ITEST Project:
Beyond CS Principles: Engaging Female High School Students in New Frontiers of Computing (Award# 1949472, 1949492, 1949488)

Principal Investigator(s):
Akos Ledeczi, Tiffany Barnes, Shuchi Grover (akos.ledeczi@vanderbilt.edu)

Co-Principal Investigator(s):
Brian Broll

Connected Spaces: A Technological Framework for Fostering Collaboration by Linking Novice Makers with Mentors and Peers



The Connected Spaces (C/S) project consists of a technological toolkit and design framework to connect geographically distributed communities of middle and highschool makers to promote collaboration between peers and facilitate mentorship and technical assistance. The toolkit consists of a suite of four technologies. First, the Dashboard, an ambient profile display for students to showcase their interests as well as evolving skills and affinities across makerspaces to support help seeking among makers. Second, the Live Portal, an always on video conference room connecting several makerspaces running activities simultaneously. Third, the Remote Embodiment for Augmented Collaborative Help (REACH), a novel communication technology consisting of two devices installed in different spaces that simultaneously project and capture a designated work area allowing distanced collaborative design and debugging around physical objects. And fourth, the Work-in-Progress (WIP) Display for students to share their evolving work with their peers. To iterate and refine the design of these technologies and test the theoretical assumptions behind them, we are running summer maker workshops for local community groups of middle schools. The extended community of practice offered by the C/S framework aims to support students in connecting STEAM competences with their personal interests and evolving identities as they experience the possibilities offered by STEM career pathways.

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Engineering
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Effective learning environments that invite young people make—to design, debug, and fabricate—artifacts to address personally meaningful problems also include opportunities to engage in core STEM+C practices of collaboration, building on the knowledge of others, mentorship, and the use of digital tools. The C/S suite of technologies specializes in supporting the development of these skills to enable distributed knowledge construction and community building across distances.

Pillar 2: Partnerships for Career and Workforce Preparation.
The C/S project is working with three community organizations to reach students underrepresented in STEM careers. DREAAM works with young black males, The Well with young black females, and the Beam Center who partners with NYCPS Summer Rising program benefiting immigrants. The C/S camps have focused on providing awareness of career opportunities in the technological and computational fields. For this summer, the expectation is to also recruit repeating participants as mentors for this summer implementation.

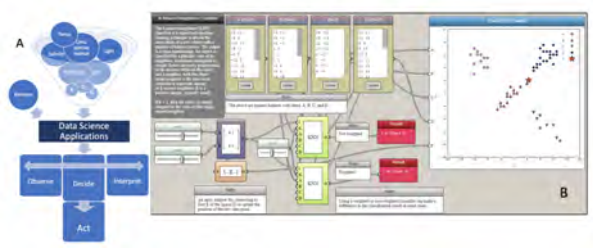
Pillar 3: Strategies for Equity in STEM Education
Studies have shown that informal makerspaces that include learners and mentors from a wide range of backgrounds appeal more broadly to young women and students of color (Desportes et al. 2022). The C/S is designed to support remote collaboration and connect learners who are underrepresented in STEM with peers and mentors. By providing an extensive community of practice, these learners will have access to support beyond their possibly limited cohorts and will begin to develop personal paths within STEM+C fields.

Related ITEST Project:
Connected Spaces: A Technological Framework for Fostering Collaboration by Linking Novice Makers with Mentors and Peers (Award# 2048833)

Principal Investigator(s):
Michael Tissenbaum (miketiss@illinois.edu)

Connecting Traditional Knowledge and Emerging STEM Through Smart AgTech

Aquaculture is historically significant to Native Hawaiians. Fishponds were essential for food production and held special cultural significance. This project will study integration of sustainable aquaculture practices embraced by Native Hawaiians for centuries with emerging agricultural technologies (AgTech) focused on sensors, measurement, and data science literacy. Students will use smart farming technologies focused on data science to make decisions on growing limu (seaweed). The Institute for Future Intelligence (IFI) and the Pacific International Center for High Technology Research (PICHTR) will collaborate to develop an integrated STEM curriculum focused on AgTech that will connect traditional and modern practices in aquaculture. This research project will investigate: 1- can the project enhance student learning of AgTech, data science and AI concepts and practices through Integrated STEM, 2- can the project increase interest in STEM when traditional knowledge are integrated into the curriculum and 3- can the project improve equitable STEM education leading to increased interest in careers in agriculture and aquaculture. Students outcomes include: learning emerging AgTech and data science practices, learning STEM within the context of historically significant aquaculture in Hawaiian society, conducting scientific research in aquaculture and preparing students to enter the STEM workforce with knowledge of current AgTech practices.



Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Chemistry , Data Science , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Suburban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
We will use integrated STEM to bring innovative technologies into the classroom. Integrated STEM require that the curriculum find ways to embed all STEM disciplines. We will develop an AgTech curriculum that uses smart farm approaches, combined with problem-based learning that will allow students some independence and creative input within the constraints of the curriculum. The Jukebox is a closed smart farm with environmental control systems and sensor technologies for data acquisition and processing.

Pillar 2: Partnerships for Career and Workforce Preparation.
The curriculum will immerse students in the growth of a historically important crop in Hawaii, limu, while preparing them for a career in AgTech. The approach we will take follows the paradigm of: Observe, Interpret, Decide and Act, connecting traditional knowledge with modern AgTech practices. Students will work with community mentors to learn both modern AgTech practices (Oceanic Institute, Windward Community College) as well as traditional Hawaiian aquaculture approaches (Waikalua Loko I‘a Fishpond).

Pillar 3: Strategies for Equity in STEM Education
This project will be launched in the Castle-Kahuku district on Oahu, Hawaii, where 43% of the student population is Native Hawaiian or Pacific Islander and 44% of the students are considered economically disadvantaged. The curriculum will focus on connecting STEM and AgTech with traditional Hawaiian practices, connecting these students with community members that may serve as mentors and future employers. Students will learn valuable STEM concepts while learning meaningful skills that contribute to food security.

Related ITEST Project:
Developing and Testing Innovations: Connecting Indigenous Culture and Integrated STEM in Hawaii Through Smart AgTech (Award# 2342700)

Principal Investigator(s):
Dylan Bulseco (dylan@rtmicrodx.com)

COVID-Inspired Data Science Education through Epidemiology (CIDSEE)

Since 2021, the COVID-Inspired Data Science Education through Epidemiology (CIDSEE) project has reached over 1,000 underserved youth nationwide, engaging them in a 15-hour out-of-school “Data Detectives Club” centered on a project-developed novel, "Pandemics!", which explores the spread of COVID, measles, smallpox, Ebola, polio, and plague. Clubs integrate data activities, modeling, animations, and career exploration. Participants use data tools and models to track the spread of infectious diseases, learn to examine time-series data, and gain confidence in their ability to use data to understand public health challenges. The program also encourages youth’s interest in careers involving the data-rich disciplines of epidemiology and public health. Our research breaks new ground on how youth, especially those who traditionally have not had access to data tools in school, examine and use time-series datasets while using accessible data tools.

Related Links: NSF Award Abstract for CIDSEE (DRL-2313212) (https://www.nsf.gov/awardsearch/showAaward?AWD_ID=2313212),Data Detectives overview and activity for ITEST PI meeting May 2024 (https://docs.google.com/document/d/1sedg3hOASGh-70CVt6xzFPCoulRIVgjg/edit)

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Data Science , Life sciences , Other
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Youth in Data Detectives Clubs use CODAP (the Common Online Data Analysis Platform) to explore data about rate of infections over time. Using CODAP, they compare data from different diseases, times and places. Youth also manipulate the parameters of a NetLogo simulation to see simulated people infecting one another as the corresponding time-series graph rises and falls. Currently we are studying whether adding sonification (playing sounds that rise and fall with changing values) to CODAP enhances youth understanding.

Pillar 2: Partnerships for Career and Workforce Preparation.
We recruit and prepare career visitors, who attend Clubs virtually to make short presentations and engage in Q&A about their work. Visitors include epidemiologists, infectious disease specialists, and data scientists, including those from partners Jackson Laboratories and Intel Corporation. Program sites also connect with in-person visitors from local CDCs or Departments of Health. Finally, the "Pandemics!" book highlights a range of historical and current careers in data and public health.

Pillar 3: Strategies for Equity in STEM Education
To increase equity in STEM education, we partner with Imagine Science and STEM Next, afterschool networks that target the hardest-to-reach children in cities served. Participants served are 28% Latinx, 21% Black, 11% multiracial, 49% girls, and 32% multilingual learners. The program leaders reflect this diversity and often live in the communities they serve. Further, "Pandemics!" highlights the contributions of Black and Latinx scientists and citizens, and one session examines racial disparities in disease burden.

Related ITEST Project:
COVID-Inspired Data Science Education through Epidemiology (Award# 2313212)

Principal Investigator(s):
Janice Mokros (Jan@tumblehomelearning.com)

Data Jam: Engaging Students with Local Ecological Data in Puerto Rico

Data Jam is an initiative of the Luquillo Long-Term Ecological Research (LTER) Schoolyard program. The Luquillo LTER at the University of Puerto Rico has collected decades of data about the El Yunque rainforest ecosystem and made that data publicly available. The Data Jam program engages middle school and high school students in the process of asking their own questions about environmental phenomena in El Yunque and then in exploring, analyzing and summarizing the long-term data as evidence to investigate their scientific research questions. Successful Data Jam projects require that students engage in a variety of data practices that underlie the STEM field of data science. The Data Jam experience culminates with students presenting their research to their peers and Luquillo scientists at a students science symposium at the visitor center in El Yunque National Forest. The project is iteratively designing and studying a professional development model that engages teachers as apprentices to ecological scientists and provides the teachers with the support they need to engage their students in data-based ecological research. Teachers participate in a weeklong summer professional development program to improve their statistical education skills and prepare them to support students conducting their Data Jam projects. During the school year, teachers participate in Virtual Lab Meetings with up to four other peers and a scientific mentor.

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Data Science , Environmental sciences , Life sciences
Geographic Location(s): Rural , Suburban , Urban

Related Links: (https://data.datajam.cloud)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Students use CODAP to conduct their analyses of data. CODAP's drag-and-drop interface creates an accessible environment for creating a variety of high-quality visualizations. The Data Jam project has curated Luquillo LTER datasets about hydrology, shrimp populations and dragonfly populations to scaffold students in using CODAP to investigate their own research questions. Data Jam provides students with structured challenge activities that build data science capacity and empower them to develop their own projects.

Pillar 2: Partnerships for Career and Workforce Preparation.
Luquillo LTER scientists serve as Data Jam mentors for both teachers & students. They meet regularly with a team of teachers to provide feedback on Data Jam progress. They also present to each teacher's class, describing their professional journey and providing an example of Luquillo research. At the end of Data Jam, the mentors attend the symposium and provide students with feedback on their posters. Both teachers and students have commented on the importance of the mentors for building students' scientific identity.

Pillar 3: Strategies for Equity in STEM Education
An important pillar of Ladson-Billings' culturally relevant pedagogy model is student empowerment. She stresses that schools should empower students to apply what they are learning to their daily lives. Data Jam exemplifies this empowerment by engaging students in conducting research about their environment. For many teachers, Data Jam is the 1st time they have been able to introduce students to authentic data from a local iconic forest. Data Jam has provided students with a new perspective on their local environment.

Related ITEST Project:
Supporting the Scientific Practice of Data Analysis through Creative Investigations of Long-Term Ecological Datasets (Award# 2049061)

Principal Investigator(s):
Steven McGee (mcgee@lponline.net)

Data Science, AI & You (DSAIY) in Healthcare

DSAIY teaches Rhode Island high school students machine learning concepts and data science skills in healthcare and medicine via a social justice lens. We aim to broaden participation in STEM through an innovative and inclusive learning ecosystem designed for evolving, interdisciplinary technologies. We are researching: how do students and teachers engage in data science and machine learning materials? How do teachers take up and enact materials? How do students engage with the learning environment and one another? We include: (1) PD to support teachers on how to use our curriculum, (2) implementation of the developed curriculum (one semester) through the differentiated lessons scaffolded on Scoutlier, (3) a Hive Learning Ecosystem meetings with topics determined by teachers to best meet their needs, (4) documentation of feedback and teacher-created resources to supplement and strengthen lessons for biannual revisions, (5) a datathon that provides an authentic workforce experience during which students team with their teachers, healthcare professionals, and data scientists to solve an authentic data based, bias-related critical care challenge. DSAIY increases students' awareness and interest in data science, machine learning, AI, and healthcare careers, particularly for historically underrepresented populations. Quantitatively, students are more interested in careers. Qualitatively, they are excited to explore data in non-biased ways and learn about diverse healthcare caree

Target Gradespan(s): High school (9-12)
Project Category: Exploratory
Discipline(s): Data Science
Geographic Location(s): Urban

Related Links: DSAIY Website (https://www.dsaihealthed.org/),MIT Critical Data 2023 Datathon Website (https://criticaldatathon.github.io/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Our program educates students in Rhode Island about the impact of bias on machine learning predictions in healthcare. We prepare students for tech careers and interdisciplinary collaboration. Our differentiated curriculum and PD makes concepts accessible to diverse learners. We ensure equitable access through tailored support tools, preparing students for engagement in community learning events. By merging cutting-edge tools with culturally sensitive methods, we engage high schoolers with expertise from diverse fields.

Pillar 2: Partnerships for Career and Workforce Preparation.
Our hive learning ecosystem includes a diverse group from across the country of healthcare professionals, data scientists, teachers, college students, and researchers from EBEC, Scoutlier, TERC, MIT, and other institutions. We developed a semester-long curriculum that engages students in Rhode Island. It is concluded with a datathon about different biases in medical research.

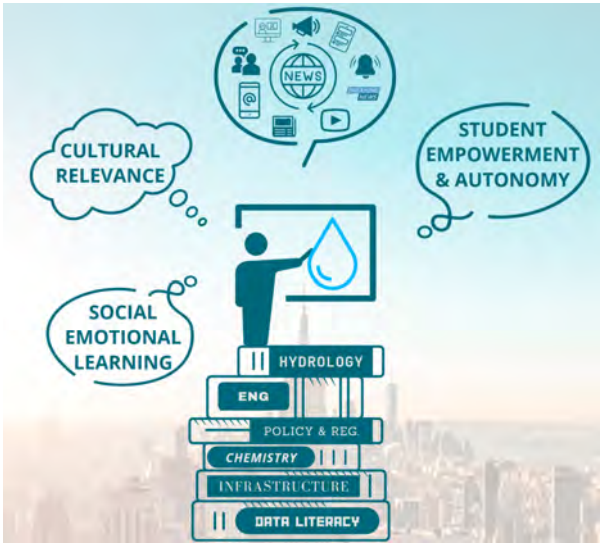
Pillar 3: Strategies for Equity in STEM Education
DSAIY is a culturally responsive program that includes many research-based strategies proven to engage student populations currently underrepresented in stem including students of color and girls.

Related ITEST Project:
A Learning Ecosystem for Teaching High School Students Machine Learning Concepts and Data Science Skills in Healthcare and Medicine (Award# 2148451)

Principal Investigator(s):
Kathryn Eller (kathryn.eller@ebecri.org)

Digital Empowerment: Can Governmental Agencies Data Platforms be Leveraged in Classrooms to Respond to Current Events?

Over the last ten months, students in New York City schools have experienced several days of haze due to wildfires, repeated urban floods, an earthquake, and an eclipse. Between fear mongering news and social media posts, students and educators may be left with a sense of confusion, if not gloom. We posit that the use of interactive information platforms from state and national agencies (e.g., NOAA, USGS, NYSDEC) can fill an information gap in real time, favorable to student-driven inquiry, civic education, and career discussions. Connections with curricular content together with digital navigation skills may transform hazardous conditions to an empowering experience, for both students and teachers.



Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Data Science , Engineering , Environmental sciences , Interdisciplinary
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Educators often rely on the use of news articles or videos to make connextions with current events. Data sets, on the other hand, are often curated, transformed or created to meet the classes need. In our project, we explore the possibility of an authentic learning experience via the use of institutional data platforms. From interactive maps to agency portals, students and educators are exposed to up-to-date measurements, sampling or reporting gaps, regulatory context, and overal data and digital literacy needs.

Pillar 2: Partnerships for Career and Workforce Preparation.
The use of authentic institutional platforms lead to explicit conversations around the source and use of the information. Students are directly exposed to a potential employer, but also invited to think about the various professions involved in the prevention, response, mitigation, regulation of these events. In addition, students are developing data literacy and navigation skills, a necessary step towards a digitally competent workforce including accessing career tools and job applications.

Pillar 3: Strategies for Equity in STEM Education
Our work takes place at the Eagle Academy for the Young Men of Harlem, a male-only predominantly Black and Latino public high school in NYC. We, teachers and researchers, have noted that the lack of cultural relevance of curricular content can be alleviated with data platforms. Developing data literacy and critical thinking skills is necessary for students to not only succeed in their STEM education, but also to tackle and address inequities (e.g., lack of, biased or underused data).

Related ITEST Project:
Engaging Young Black and Latino Students in Data Science Through Water Security (Award# 2048958)

Principal Investigator(s):
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Co-Principal Investigator(s):
Laureline Josset

Digital Mathematics Storytelling in Newcomer Communities

During Spring Break of 2024, children from recently immigrated families took part in a weeklong Superhero Digital Math Storytelling Camp at a community center focused on newcomer communities. As part of an ITEST CAREER research grant, this project focused on engaging children in crafting narrative and counternarratives that explored the ways that mathematics connected to their real-life experiences. In this camp, the children used the superhero genre to create their own superheroes, crafting origin stories that become counternarratives to push back on the ways that the children have had to navigate the confusing rules of assimilating to the USA. Many of the children are from families seeking asylum in the USA, so their superhero narratives alluded to their experience with war, military occupation, displacement, and trans-national identity. Through a focus on developing a storytelling community to explore mathematics identity and counter storytelling, the children ended up creating comics and videos featuring their superheroes. Utilizing a critical digital literacies framework, the children learned how to create comic stories, shoot, and edit video, record voiceovers, and ultimately create the story they wanted to tell. And through the use of storycircles, in which children shared their stories in progress and got feedback, the children were able to create counter narratives using their superheroes as protagonists and antiheros to solve real world mathematics problems.

Target Gradespan(s): Elementary school (K-5)
Project Category: Youth-Based
Discipline(s): Mathematical sciences
Geographic Location(s): Urban

Related Links: (https://www.digitalmathstorytelling.com/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The children in the project engaged in Digital Mathematics Storytelling. This meant that they had to write and digitally record an audio narrative. Then, they had to storyboard, film, and then edit the visual narrative. And finally, they had to edit it all together into a cohesive video or story. Through this, the children were engaged in innovative use of technologies in the ways they collaborated, planned, shot, and edited their final stories.

Pillar 2: Partnerships for Career and Workforce Preparation.
Throughout the Superhero Digital Mathematics Storytelling camp, children were able to explore the ways media literacy connected to potential careers. The children worked with professional media and content creators to write and record their narratives, plan out their story, and ultimately, shoot and edit their final product. This exposure to critical digital literary skills helped these children, aged 7-14, develop quick expertise in digital content creation and learn how digital media professionals operate.

Pillar 3: Strategies for Equity in STEM Education
This camp centered on children who are marginalized in their school mathematics settings because of linguistic, cultural, or socioeconomic barriers. We emphasized mathematics play and problem solving and how these can help children connected back to their community and family funds of mathematical knowledge. And because many of the participants were reluctantly displaced from their homeland, this emphasis on mathematics helps them only develop a long-term positive mathematics identity.

Related ITEST Project:
Digital Mathematics Storytelling: Fraction Stories from Urban Emergent Communities (Award# 1943208)

Principal Investigator(s):
Theodore Chao (chao.160@osu.edu)

Diving into Discovery: AI and Paleontology in Middle School

The project aims to integrate paleontology and machine learning (ML), a subfield of artificial intelligence (AI), to develop a curriculum for middle school teachers and students. Teachers attend a weeklong professional development workshop at the University of Florida to learn about AI and gain experience with the curriculum before implementing it. Over three cohorts, approximately 50 teachers will be recruited to participate in the project and to implement curricular activities in their classrooms. During implementation, STEM experts will conduct virtual or in-person classroom visits as role models. Students will learn about ML concepts, and potential future careers in AI, develop ML models to classify fossil shark teeth by form and function, and conceptualize their own ML model. The project seeks to target engagement with Title I schools in Florida to encourage underrepresented groups to increase awareness of STEM and computational technology careers. The project investigates questions on the effective integration of emerging technologies in teachers' existing K-12 science curricula. For example, teachers' (mis)conceptions of AI in K-12 science education, teachers' AI self-efficacy, students' attitudes toward science, STEM expert and teacher partnerships, and students' conceptualization of ML models.

Related Links: (https://education.ufl.edu/sharkai/)

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Life sciences
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Our project is focused on computer vision, which leverages machine learning to classify images based on feature extraction. Project participants utilize Google's Teachable Machine to develop models capable of classifying fossil shark teeth. In the first year, participants also developed models using another platform, Roboflow; however, we found this platform to not be ideal for our middle school audience. Using ML in this context provides an innovative way to pique student interest and curiosity in STEM subjects.

Pillar 2: Partnerships for Career and Workforce Preparation.
The project sustains valuable collaborations through STEM expert-teacher partnerships. Many of the partnerships begin to be established during the teacher PD workshop. During this time, teachers hear from experts and scholars about what AI/ML is, how they use it, and future career opportunities for students. Following the workshop, experts will visit classrooms to provide content support and serve as role models as they discuss their career path and current role.

Pillar 3: Strategies for Equity in STEM Education
The project focuses on equity in STEM education through its focus on Title I schools. Schools of greatest need are prioritized through the teacher recruitment process. Title I schools serve a high percentage of students from low-income families, many of whom belong to underrepresented groups in STEM fields. By targeting these schools, the project aims to address educational disparities and provide access to innovative STEM learning experiences for students who may have limited resources or opportunities.

Related ITEST Project:
Integrating AI Machine Learning into the Teaching of Paleontology Using Fossil Shark Teeth in Middle Schools (Award# 2147625)

Principal Investigator(s):
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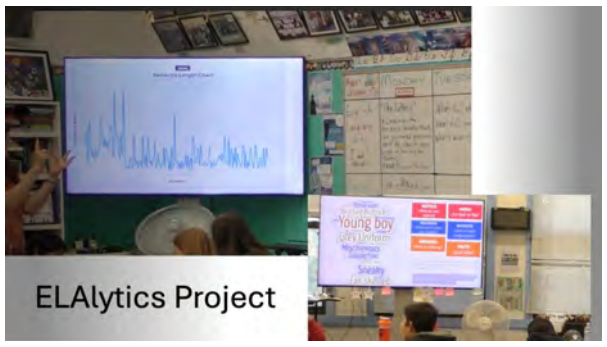
Co-Principal Investigator(s):
Pavlo Antonenko, Jeremy Waisome, Victor Perez

ELAlytics: Exploring the intersections of Data Literacy and Literary Literacy in the classroom

Data visualizations are emerging as ways to examine and “see” literary texts in new ways by making salient the countable and quantifiable features of a book, story, or other composition. Taking seriously the potential for literary literacy and data literacy to be complementary and mutually supportive in interpretive work, this project involves cycles of co-design with middle school English language arts teachers to bring text analytics visualizations into their classroom instruction through new tools and resource creation. This project is being implemented in urban middle school classrooms as tools are developed and refined and the new learning interactions that can result from this integration are studied.



Target Gradespan(s): Middle school (6-8)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Data Science
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Using text analysis tools and packages available online, this project creates a variety of visualizations of texts that are used as part of the middle school English Language Arts curriculum, structured to support data and ELA learning goals

Pillar 2: Partnerships for Career and Workforce Preparation.
The approach of this project is to recognize literary reading and analysis strategies as complementary and valuable for work with data and to make the analysis of text through computational treatments of it as quantifiable data another tool for students. This will prepare for the shift in how data is used professionally across disciplines.

Pillar 3: Strategies for Equity in STEM Education
By providing more resources for students to engage in interpretation and sense-making, especially when language can be an additional challenge, this project provides pathways and alternatives for participation and analysis for students who may otherwise not be provided those additional meaning-making resources.

Related ITEST Project:
Building STEM Skills by Integrating Data Literacy and Text Analytics in English Language Arts (Award# 2241483)

Principal Investigator(s):
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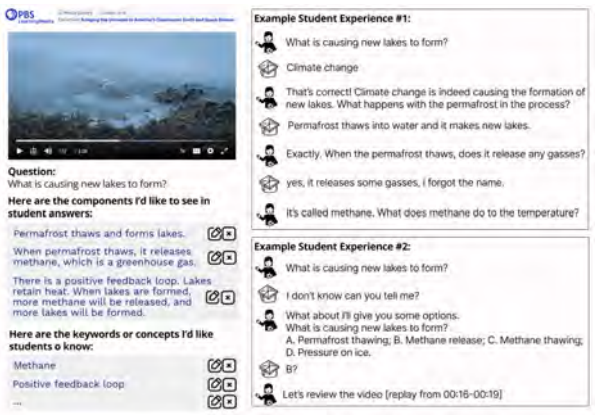
Co-Principal Investigator(s):
Sarah Levine, Dora Demszky

Embedding LLM-powered conversational tutors in STEM videos through teacher-AI collaboration



Target Gradespan(s): High school (9-12)
Project Category: RAPID
Discipline(s): Environmental sciences
Geographic Location(s): Urban

The rapid advances in LLMs present tremendous opportunities to create interactive, personalized learning experiences at scale. However, to truly harness the educational potential of these technologies, it's crucial that teachers - who are at the forefront of daily student interaction and possess indispensable knowledge and expertise - go beyond being mere consumers to key contributors. This one-year project proposes a teacher-AI collaboration paradigm that can potentially realize this vision. In this project, we partner with WGBH Educational Foundation (GBH) to support teachers to create and customize intelligent tutor accompanying the STEM learning resources available on PBS LearningMedia. We have performed an interview study with high school science teachers to understand how they teach videos in their lessons. Teachers overwhelmingly liked engaging students in a conversation about the video as a method for inquiry and learning. The interview study shed light on the tutoring strategies teachers would use. For example, teachers make sure the questions do not go beyond the scope of the video, and they do not probe further when the students begin to get frustrated. Based on the findings, we are developing a platform that enables teachers to configure LLM-powered conversational tutors for STEM videos. We employ LLM alignment techniques and human-AI collaborative techniques to ensure that the conversational tutors provide a safe and desirable learning experience to students.

Pillar 1: Innovative Use of Technologies in Learning and Teaching
This project aims to embed conversational tutors to help students learn videos, which is an innovative learning experience for students. Moreover, this project innovates teacher-AI collaborative mechanisms in supporting teachers to configure and customize dynamic tutoring experience for students' interaction with AI. This project will experiment with and combine LLM alignment techniques, RAG techniques, multi-agent approaches, and human-AI collaborative techniques in novel ways.

Pillar 2: Partnerships for Career and Workforce Preparation.
We partner with WGBH Educational Foundation (GBH), Boston's PBS station, to support teachers to create and customize intelligent tutor accompanying the STEM learning resources available on PBS LearningMedia, a platform already popular among teachers nationwide, for its comprehensive library of over 5,000 high quality STEM-focused videos and millions of users. Our prototype will embed conversational tutors in STEM videos on PBS LearningMedia.

Pillar 3: Strategies for Equity in STEM Education
First, the conversational tutors would in particular benefit students who have limited access to expert teachers. One of the aims of this project is to provide personalized learning experiences at scale with the conversational tutors. Second, the conversational experience provides scaffolding during the students' question answering process. This may in particular help the students who do not do well in traditional problem-solving or question answering activities.

Related ITEST Project:
Empowering Teachers to Collaborate with Generative AI for Developing High-Quality STEM Learning Resources (Award# 2335975)

Principal Investigator(s):
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Embodied CT in a Mixed-Reality environment

Target Gradespan(s): Early Childhood (PK) , Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science
Geographic Location(s): Rural

Our primary goal is to enhance children's problem-solving and computational thinking (CT) skills through engaging and interactive embodied learning experiences. To achieve this, we've created a unique mixed-reality learning environment designed specifically for young children. In this innovative setting, children engage in activities where they mimic robot movements—they move forwards and backwards, and turn right or left according to predefined symbols. This interactive environment is designed to resemble a path-finding game where kids undertake various missions in sequence. These missions challenge the children to understand and use symbols and sequences, which are fundamental concepts in CT. The mixed-reality environment makes learning immersive, allowing children to physically act out problem-solving processes by moving around a chessboard-like floor while interacting with virtual objects. As they move and complete missions, they receive real-time feedback from the system, which helps them ground abstract CT concepts in their bodily actions. These embodied learning activities in the mixed-reality environment are designed to be integrated into other learning activities, such as unplugged activities and robot programming. This integration ensures a well-rounded learning experience that is both fun and effective, making complex ideas tangible and understandable through bodily actions, immersive experiences, and gameplay.

Related Links: (https://learnct.iu.edu)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Augmented Reality (AR) technology is utilized to create a mixed-reality learning environment where children can engage in immersive, embodied learning experiences. Motion detection technology enables the system to provide immediate feedback on the children's physical actions, facilitating a congruent embodied learning experience.

Pillar 2: Partnerships for Career and Workforce Preparation.
Six teachers from two rural schools participated in the project. Initially, the research team provided them with professional development sessions and demonstrated how to effectively teach the curriculum. Throughout the project, teachers were encouraged to actively engage in curriculum design, offering insights on learning activities and assisting with the planning of curriculum implementation. Together, the teachers and the research team successfully established a research-practice partnership.

Pillar 3: Strategies for Equity in STEM Education
Recognizing the unique perspectives of girls in rural areas, we've integrated culturally resonant elements into our curriculum, such as treasure hunts and familiar animals like squirrels and raccoons. This approach makes the content engaging and relatable. Additionally, socio-emotional learning components in our curriculum foster empathy and scientific inquiry through missions that involve helping animals.

Related ITEST Project:
Supporting Early Learning of Computational Thinking Using Mixed Reality Technology (Award# 2048989, 2049046)

Principal Investigator(s):
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Co-Principal Investigator(s):
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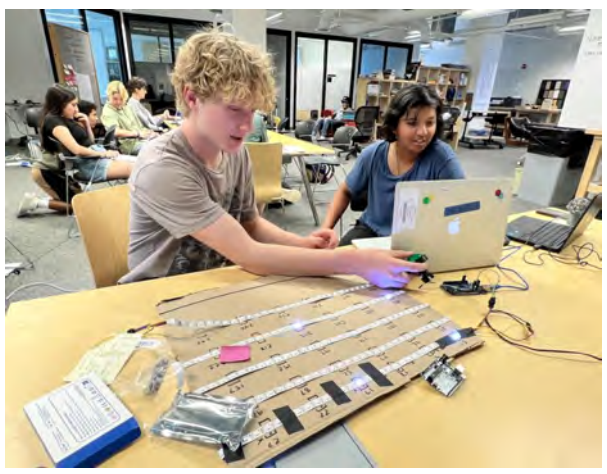
Empathy-Driven Engineering Internships for Teens: Designing for Accessibility

Centered around principles of universal design, designing for accessibility, and engineering with empathy, the Build a Better Book Teen Internship program examines how teen interns' perceptions of engineering and self-identities as engineers are formed and cultivated as they design and create more accessible products for authentic community clients who are blind or have low vision. Many teens have a limited understanding of what engineering is and what engineers do, and often their perceptions do not align with their interests and strengths. This project aims to impact teens' perceptions of engineering, their engineering identities, and their confidence and competence in engineering and 21st century workplace skills. Using a design-based research approach, the internship model is being tested at four sites around the country, including a school, public library, university, and science museum. Data collected from each site include pre-/post-surveys and audio/video reflections, interviews with site leaders, a culminating focus group discussion, and artifacts created through the program (i.e., products designed for community clients). Early findings suggest positive changes across sites, including broader perceptions of engineering and shifts in engineering identity, increased confidence and competency in technical skills, and gains related to 21st century workplace skills, such as communication and collaboration.



Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI) , Research Study , Youth-Based
Discipline(s): Engineering
Geographic Location(s): Suburban , Urban

Related Links: Build a Better Book Teen Internship Program (https://www.colorado.edu/project/bbb/teen-internship-program)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Build a Better Book Teen Interns use a variety of maker tools and technologies–including 3D printers, laser cutters, electronics, sound boards, and computer programming–to create accessible products that meet an authentic community need. Interns are challenged to creatively use these technologies to expand access to information, specifically for those with visual impairments. The internship provides training and mentorship to develop teens' technical skills, and emphasizes an iterative engineering design process.

Pillar 2: Partnerships for Career and Workforce Preparation.
Across sites, the BBB Teen Internship program aims to expose teens to career opportunities in engineering while developing their 21st century workplace skills. Internships provide pay or school credit; youth apply, have set hours and job expectations, collaborate in teams, and are held accountable for deliverables. Throughout the internship, teens participate in relevant tours, campus visits, and virtual and/or in-person meetings with STEM professionals, to expand their awareness of engineering career pathways.

Pillar 3: Strategies for Equity in STEM Education
With its focus on broadening participation in engineering and expanding accessibility for people with disabilities, particularly those who are blind or have low vision, equity is at the core of the Build a Better Book Teen Internship program. The program supports youth from groups underrepresented in engineering, including girls and students of color, by providing paid internship positions and connecting them with STEM mentors. Community clients provide feedback and help guide interns throughout the design process.

Related ITEST Project:
Empathy-Driven Engineering Internships for Teens: Connecting Technical Work to Social Needs (Award# 2049109)

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Co-Principal Investigator(s):
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Enabling Mathematics Teachers' Research to Expand Latinx Learners' Authentic Experiences in Computer Programming (ESTRELLA)

ESTRELLA draws from an interdisciplinary research team with areas of expertise in electrical and computer engineering, bilingual education, and mathematics education. The team collaborates with middle and high school teachers to co-design lessons that advance student understanding of mathematics through computer programming of visual representations. Teachers conduct action research projects to study topics of interest to them as they implement this integrated curriculum. For example, the middle school teacher focused on fractions and the relationship between distance, rate, and time. The high school teacher focused on geometry and exponential growth and decay. Over the past two years, ESTRELLA has served 101 middle and high school students from primarily Latinx backgrounds and two teachers. Both teachers are supported to implement the integrated mathematics and computer programming curriculum by the researchers and a group of 5 undergraduate engineering students who are from diverse backgrounds. The teachers can choose to add support by including middle school student co-facilitators. The middle school student co-facilitators and the undergraduate student facilitators attend professional development focused on understanding the same mathematical tasks that their students will engage with; best teaching practices; and asset-based approaches to working with culturally and linguistically diverse students.

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary
Geographic Location(s): Urban

Related Links: (http://estrella.unm.edu)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
To broaden the participation of Latinx students in STEM, we use Google Colab notebooks openly available at https://github.com/pattichis to support teachers in co-designing mathematics lessons. These lessons include fractions; distance, rate, and time; geometric transformations; and exponential growth and decay. Students use image and video representations to understand mathematics and programming concepts in their final projects. Through action research projects, teachers reflect on how to improve mathematics lessons.

Pillar 2: Partnerships for Career and Workforce Preparation.
All students participating in ESTRELLA are exposed to computer programming in their mathematics classrooms. The charter schools that we partner with have access to the local university and include coursework that prepares students for careers in STEM. Other schools that have expressed interest in participating in our project in the future also have industry partners involved in recruiting students for internships and work with students to support ongoing projects.

Pillar 3: Strategies for Equity in STEM Education
ESTRELLA's central goal is to broaden the participation of Latinx students in STEM fields. These students are in secondary mathematics classrooms in rural and urban school contexts. The co-designed lessons that integrate mathematics and computer programming are taught in small groups using students' language preference of Spanish or English. Furthermore, the professional development sessions prepare facilitators to center students' home language and interests as resources to draw from while teaching and learning.

Related ITEST Project:
Developing and Testing Bilingual Curricula that Infuse Authentic Computer Programming Experiences into Middle School Mathematics for Latinx Youth (Award# 1949230)

Principal Investigator(s):
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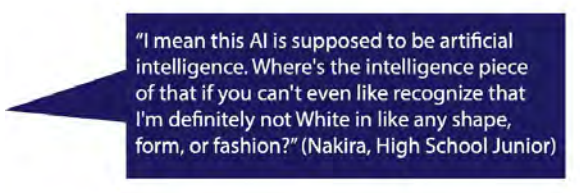
Co-Principal Investigator(s):
Sylvia Celedon-Pattichis, Carlos Lopez Leiva

Engaging High School Youth in Algorithmic Justice Through Audits of Designed and Everyday Machine Learning Applications

This project investigates how youth engage with algorithm auditing, a method that involves repeatedly querying AI/ML algorithmic systems and observing their output in order to draw conclusions about the system's opaque inner workings and possible external impact. We investigate how youth audit everyday ML applications. More specifically, (1) the feasibility of user-led algorithm audits by youth, (2) the dynamics of collaboration in algorithm audits, and (3) youth understanding of algorithmic justice through auditing.



Research Questions

1. What are high school youth experiences and understandings of everyday ML applications?
2. How do high school youth design and conduct collaborative audits of ML applications?
3. How can high school youth apply audit approaches to applications they encounter in their everyday lives?

Accomplishments to date

- Conducted participatory design sessions with 7 high school youth to design algorithm auditing learning activities.
- Piloted algorithm auditing learning activities during 6 after school workshops with 21 high school first year students.
- Developed a sequence of steps to involve youth in algorithm auditing activities.

Equity

- Participants are majority urban youth of color, a group systematically underserved in STEM
- Investigating algorithmic justice and bias issues

Future work

- Integrate auditing activities into youth design processes of ML applications (summer workshop).
- Co-design auditing activities with teachers (see NSF grant #2342438).
- Integrate and implement auditing activities in formal classrooms (see NSF grant #2342438).

Related ITEST Project:
Engaging High School Youth in Algorithmic Justice Through Audits of Designed and Everyday Machine Learning Applications (Award# 2333469)

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Co-Principal Investigator(s):
Danaë Metaxa

Engaging Rural Students in Artificial Intelligence to Develop Pathways for Innovative Computing Careers

Advances in AI are fundamentally reshaping the workplace of the future and accelerating the demand for creating and sustaining an AI-literate workforce. This demand highlights the importance for all K-12 students to develop an understanding of AI to prepare them for future careers. The AI Play project introduces AI concepts to middle grades students (ages 11-14) and teachers through workshops, camps, and school-based programs in rural communities of North Carolina. With a focus on fostering students' creative expression, the learning environment will infuse AI learning into interactive digital game design activities that enable students to create personally meaningful game scenarios. To address the need to broaden participation in the STEM workforce, youth from historically underrepresented groups in STEM fields have been recruited to participate in week-long AI Play Exploration Camp where they engage in AI learning experiences. Students also participate in interactive presentations and demonstrations led by industry professionals from the Research Triangle Park exploring how AI is enhancing the workplace. The AI Play project offers professional development sessions that support teachers as they introduce AI to their students. The project is investigating which AI concepts in the context of digital games are most appropriate and engaging to students, and what are the support and scaffolding that teachers require in integrating AI education into their instructional designs.

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Rural

Related Links: (https://go.ncsu.edu/aiplay)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The AI Play project integrates the 5 Big Ideas in AI —perception, representation & reasoning, learning, natural interaction, and societal impact—into dynamic, game-based learning activities, tailored to rural middle grades students. These activities center on applications for pathfinding, facial recognition, conversational NPCs, and autonomous gameplay agents. This approach allows students to explore AI through digital game design and playful experiences, enhancing their learning in an engaging and interactive manner.

Pillar 2: Partnerships for Career and Workforce Preparation.
A highlight of the AI Play summer camps are the interactive presentations and demonstrations by professionals from the Research Triangle Park. Complementing their presentations are engaging group discussions, interactive demonstrations, and hands-on activities highlighting AI uses throughout STEM fields. To understand if AI Play develops targeted outcomes for students, we are investigating students' attitudes toward AI and students' interest in AI careers.

Pillar 3: Strategies for Equity in STEM Education
Our work intentionally recruits from and works closely with students and teachers from underserved communities, specifically from rural areas of North Carolina that often have lower socioeconomic levels, educational attainment, and access to technology-rich learning opportunities. We continuously refine our educational materials and software based on feedback from students and teachers in rural communities to ensure our learning and teaching technologies are both age-appropriate and relevant to rural settings.

Related ITEST Project:
Engaging Rural Students in Artificial Intelligence to Develop Pathways for Innovative Computing Careers (Award# 2148680)

Principal Investigator(s):
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Co-Principal Investigator(s):
Wookhee Min, Veronica Cateté

Engaging, educating, and empowering families in STEM through home-school-community partnerships

SISTEM is supporting PreK students' integrated science, language, and literacy learning by creating a coherent model of family-school-community partnership with a focus on multilingual learner's (MLs). EDC and the Connecticut Science Center (CSC) are collaborating to engage children, families, teachers, and the community to form powerful partnerships that fuel children's science and language learning across multiple settings. The project aims to enrich the quality and quantity of science and language learning environments for young MLs, building their confidence in doing and learning science and introducing them to a variety of STEM career options. SISTEM contributes to children's STEM interests, self-confidence, and foundational habits of mind by activating 4 synergistic approaches: • engaging families of MLs as their children's STEM advocates • promoting teachers' pedagogies in inquiry, oral language, and family engagement for MLs • forging strong relationships among families and teachers and • creating home/school/community STEM partnerships. Ultimately, SISTEM aims to support families, teachers, formal and informal science educators, and STEM workers in local communities to create and facilitate experiences for young children that spark children's scientific thinking, interest, and confidence in doing and learning science, while promoting language learning and raising awareness of the value of creating a science learning ecosystem across home, school, and community.

Related Links: (https://www.edc.org/supporting-science-inquiry-interest-and-stem-thinking-young-dual-language-learners-sistem)

Target Gradespan(s): Early Childhood (PK)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Other
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
SISTEM employed innovative uses of technology to: (1) support children's inquiry at home and school using PEEP and the Big Wide World/El Mundo Divertido de PEEP parent and teacher-facing resources; (2) supported home/school connections using photos and videos; and (3) enriched teacher coaching with virtual PLCs. PEEP's resources include three mobile apps that provide guidance for engaging children in physical science while supporting inquiry and language development.

Pillar 2: Partnerships for Career and Workforce Preparation.
SISTEM expanded existing home-school-community partnerships to include local STEM industry partners and increased access to diverse STEM professional role-models. SISTEM promoted STEM workforce preparation for PreK children by recruiting STEM community helpers from local industry and building on the PreK theme of "community helpers" which fosters children's understanding about who lives and works in their community. STEM community helpers engaged children, families and educators at the CSC in fun and playful ways.

Pillar 3: Strategies for Equity in STEM Education
SISTEM focused on PreK MLs and their families who have historically been underserved by the science and STEM education community and used the Dual Capacity-Building Framework to strengthen schools' and teachers' ability to welcome and engage ML families, and to effectively harness the power of ML's informal experiences at home and in the community to support children's interests and confidence in doing and learning science. Family/teacher workshops promoted home/school collaborations that fuel ML's science learning.

Related ITEST Project:
Supporting Science Inquiry, Interest, and STEM Thinking for Young Dual Language Learners (Award# 1949266)

Principal Investigator(s):
Jessica Young (Jyoung@edc.org)

Equitable Access to STEM Career Pathways

This collaborative research project aims to foster STEM identity development among historically underrepresented Latinx middle school youth by integrating STEM skill-building with personalized career exploration and planning. The study involves a collaboration between Sociedad Latina, a youth-serving organization, and Boston University to provide students with culturally responsive network science and career development curricula in after-school and summer program settings. Using career narratives and a quasi-experimental pretest-posttest design, the study examined changes in STEM career identity and self-efficacy. Career narratives, in particular, were used to understand the development of STEM career identity with an aim to increase the number of youth developing STEM career identities and entering high school intending to pursue STEM careers. Using the Life Design perspective, students created comic strips by "reflecting" their existing talent, skills, and experiences, as well as the decisions they made and/or are making in relation to their career goals (Savickas et al., 2009). The findings revealed that students developed deeper reflections on their talents and skills relevant to STEM careers and the number of youths intending to pursue future STEM careers increased after the program participation. The study also showed improvements in self-efficacy, with network science lessons having a significant large effect and career lessons having a meaningful medium effect.

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Other
Geographic Location(s): Urban

Related Links: (https://youtu.be/XyGLWvrk1dc?si=cIV3FJ2lalc6fTEF)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
To examine the development of STEM career identities among Latinx youth, we have incorporated an online platform "Pixton," which allows youth to create their own stories using different characters and comic strip templates. The platform provides a wide array of avatar options that represent different races, ethnicities, and cultures, helping youth create a character that reflects how they see themselves.

Pillar 2: Partnerships for Career and Workforce Preparation.
By leveraging Sociedad Latina's expertise in culturally responsive programming and deep connections within the community, the project was able to effectively engage and support historically underrepresented Latinx middle school students in developing their STEM identities and career aspirations.

Pillar 3: Strategies for Equity in STEM Education
To promote equity in STEM education, the project employed several key strategies: (1) integrating STEM skill-building with personalized career exploration and planning, (2) using career narratives and comics to foster STEM identity development, and (3) adapting the program to address challenges posed by COVID-19. These strategies aimed to increase access, engagement, and success for historically underrepresented Latinx youth in STEM pathways.

Related ITEST Project:
Network Science for All: Positioning Underserved Youth for Success in Pursuing STEM Pathways (Award# 1949526, 1949484)

Principal Investigator(s):
Alexandra Oliver-Davila, Kimberly Howard (development@sociedadlatina.org)

Equity Strategies of the Head, Heart, and Hands: A Networked Improvement Community Approach to Designing for More Inclusive Informal STEM Learning Environments

The CISTEME365 initiative is in its 6th year of implementation, and despite contextual changes that occurred over the years, this project has remained true to its three pillars of engagement: (1) building a professional learning network for school-based teams made up of counselors, teachers, and other relevant school stakeholders with professional development aimed at providing more equitable and inclusive STEM environments, (2) supporting the implementation of STEM-enrichment clubs at each school site, and (3) offering fully-covered scholarships for STEM club student participants to attend STEM-immersive summer camps at the University of Illinois.

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Strategies
Discipline(s): Engineering

Related Links: CISTEME365 Project Website (https://cisteme365.engineering.illinois.edu/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
School-based teams of teachers and counselors (IDEA Teams) engage in year-round professional learning that begins with a summer institute focused on project-based learning in electrical engineering and strategies for creating equitable and inclusive STEM environments. IDEA Teams put learning into action by forming STEM clubs in their home schools and engaging in Action Research for Equity Projects. Monthly Networked Improvement Community sessions via Zoom allow teams to share progress and to troubleshoot challenges.

Pillar 2: Partnerships for Career and Workforce Preparation.
CISTEME365 is a partnership between The University of Illinois' Grainger College of Engineering, the National Alliance for Partnerships in Equity, and participating schools. A focus on out-of-school time for STEM learning increases the competitiveness of engaged students when compared to their peers from high-resource, high-access communities. Introducing students to a range of career opportunities and to engineers from diverse backgrounds, the students are able to better envision themselves in future STEM careers.

Pillar 3: Strategies for Equity in STEM Education
By uniquely embedding equity and inclusion strategies with training in STEM technical concepts, educators are better able to see the relationship between these two, often siloed topics. The Action Research for Equity Project provides a tool that can be used well into the future for assessing efforts to increase equity and inclusion in STEM. A key product resulting from the CISTEME365 initiative is the Head, Heart, & Hands rubric for Designing Inclusive STEM Learning Environments.

Related ITEST Project:
Catalyzing Inclusive STEM Experiences All Year Round (CISTEME365) (Award# 1850398)

Principal Investigator(s):
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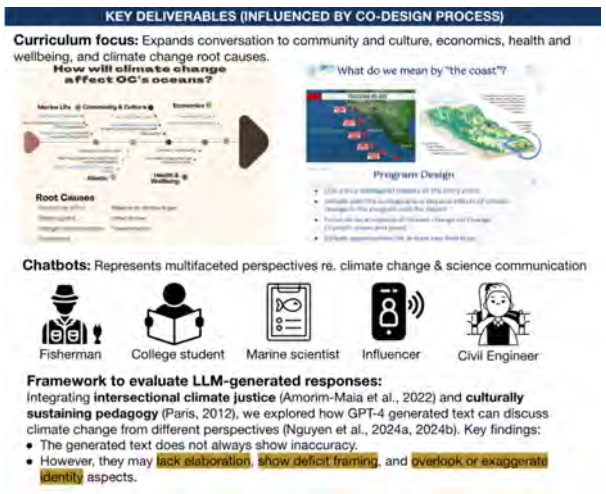
Co-Principal Investigator(s):
Lara Hebert

Equity-Centered Design Of Conversational Agents For Climate Change Communication

We are presenting on Year 1 of a three-year, NSF-funded project (2023-2026) entitled Agents for Inclusive Science Communication (AISciComm). The project involves a research-practice partnership between University of California-Irvine, Utah State University, and Orange County Department of Education. Our main goal is to support high school students (grades 9-12) in Title I schools in Orange County (OC), California to develop systems understanding that (1) reflects how climate change will impact the local marine ecosystems, and (2) integrates the perspectives of community stakeholders. To these goals, we have co-designed different AI chatbots with high school teachers, students, and informal science educators. Using GPT-4 as the base model, the chatbots represent various community perspectives -- that students interact with in open-ended exchanges to refine their systems models. Students also develop their own AI-integrated products to represent their thoughts on climate change topics. These activities prompt students to consider human-centered factors often overlooked in systems models of climate change, as well as develop understanding of inclusive science communication and AI literacy.



Target Gradespan(s): High school (9-12)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Environmental sciences , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
We have developed AI chatbots (GPT-4 as the base model) to represent community perspectives, and learning activities about marine ecosystems, science communication, and AI literacy. We have also developed a framework encompassing intersectional climate justice and culturally sustaining pedagogy perspectives, to evaluate and refine the prompts for GPT-4 to convey scientifically accurate, locally grounded, and diverse perspectives without bias.

Pillar 2: Partnerships for Career and Workforce Preparation.
The phenomena that students investigate—impacts of human activities on ecosystems and community-wide climate actions—represent complex environmental challenges faced by communities beyond coastal California. Communicating about these issues can perpetuate inequities if the communication approaches do not account for the voices of marginalized populations. We examine the routines and principles that facilitate participation and agency among co-design participants.

Pillar 3: Strategies for Equity in STEM Education
Building on inclusive science communication and equity-centered RPP, we utilized participatory approaches to design and evaluate the chatbots and learning activities. We conducted 8 co-design sessions with a team of students, formal and informal science educators, and researchers. We conducted interviews with community members to evaluate the AI output. Our research provides insights into how youth leverage their cultural, social, and personal identities in CA interactions, and how these interactions shape learning.

Related ITEST Project:
Equity-Centered Design of Conversational Agents for Inclusive Science Communication Education in High Schools (Award# 2241596)

Principal Investigator(s):
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Co-Principal Investigator(s):
Ha Nguyen

Everyday AI has an AI Literacy curriculum, assessment tools, and a PD model to share!

Everyday AI (EdAI) addresses the need to develop a diverse workforce with the knowledge and skills to work with AI and answers the call for widely-accessible and age-appropriate AI Literacy education. Broadening participation in AI is important in ensuring that AI technologies are founded on principles of inclusivity and equitability. MIT and Boston College prepared over 120 middle and high school teachers from districts across Florida, Illinois, New York, Virginia, and New Mexico who tengaged over 4800 middle and high school students in AI lessons and activities that built students' interest in AI and AI-enabled industries of the future. The majority of the students are from Black and Latinx families. EdAI was built upon the Developing AI Literacy (DAILy) curriculum that interweaves AI concepts, ethics in AI, generative AI, and AI career and futures. The EdAI professional development (PD) program takes a multi-pronged approach offering an AI Book Club, a Summer Practicum, and an online Community of Practice. Our research investigates how this PD model supports teachers to learn, adopt, modify, and teach the DAILy curriculum in a wide range of classroom settings and how the teachers' implementation of the curriculum impacts student learning. Over the past 1.5 years, through US Dept. of Education funding, EdAI has partnered with New Mexico State University to scale the project across New Mexico and study its impact on Rural, Hispanic, and Indigenous communities.

Related Links: Everyday AI Teacher Professional Development Network (https://everyday-ai.org/)

Target Gradespan(s): Middle school (6-8) , High school (9-12) , Other
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Interdisciplinary
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The Everyday AI program examines an innovative model for the advancement of teacher content knowledge, pedagogy, and self-efficacy to develop their students' AI Literacy. Through its PD model, in-service middle school teachers of all subject areas learn to implement the Developing AI Literacy (DAILy) curriculum, which uses participatory simulations as well as unplugged activities, to foster students to become critical consumers, ethical designers, and active participants in democratic discussions around AI.

Pillar 2: Partnerships for Career and Workforce Preparation.
Everyday AI partnered with CodeVA, CornellTech, and STEAMAhead to launch AI summer camps across the country that serve as practicum experiences for teachers. In summer camps and in their classrooms, teachers implemented DAILy lessons on AI careers which seed workforce awareness among middle and high school students. Students first daydream about careers of interest. Then, they identify jobs that match their interests and investigate how AI might impact these jobs. Finally, they outline steps to attain their dream job.

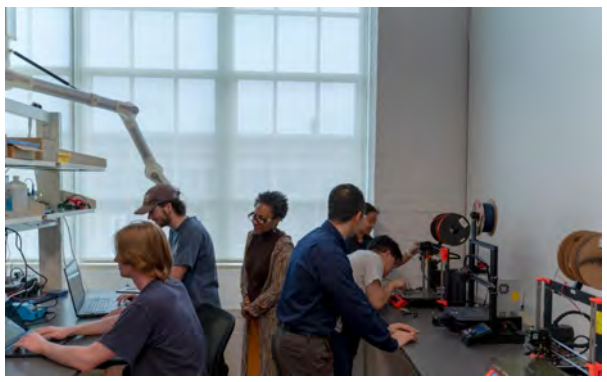
Pillar 3: Strategies for Equity in STEM Education
Everyday AI partners with organizations that have strong community ties to assist with the recruitment of teachers and students of color. Within our PD, teachers are encouraged to modify DAILy lessons to fit their community context, increase cultural relevance, and provide students with choice and voice. Experienced EdAI teachers are invited to return as coaches to support teachers in their school or district. This mechanism has enabled EdAI to generate a diverse facilitation corps and support underserved communities.

Related ITEST Project:
Everyday AI for Youth: Investigating Middle School Teacher Education, Classroom Implementation, and the Associated Student Learning Outcomes of an Innovative AI Curriculum (Award# 2048746)

Principal Investigator(s):
Irene Lee (ialee@mit.edu)

Co-Principal Investigator(s):
Helen Zhang

Foster AI Learning for Smart Manufacturing



Target Gradespan(s): High school (9-12)
Project Category: Exploratory , RAPID , Research Study
Discipline(s): Engineering , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Rural , Suburban , Urban

The integration of artificial intelligence (AI) into advanced manufacturing has promising potential to revolutionize productivity and generate new jobs in smart manufacturing. There is an urgent need to investigate "what to teach" and "how to teach" AI in order to prepare future workforce with the necessary AI skills. This project will initiate an age-appropriate career-driven AI educational program for high-school students and evaluate its effectiveness. We will develop manufacturing specific AI learning modules to teach high school students about additive manufacturing that will be equipped with real-time process monitoring, analysis and communication. We have three objectives: design AI learning modules of smart manufacturing for high-school students, develop project-based learning (PBL) experiences, collect firsthand survey data among participants and use data-driven methods to evaluate the effectiveness in improving AI learning and promoting future education and career in smart manufacturing. We will focus on underserved high schools and underrepresented groups to promote equitable learning. The successful outcomes of the project will be the concrete AI concepts and skills needed for smart manufacturing, the new PBL pedagogy for AI educational intervention, and the insights from data-driven analysis about the intervention. These outcomes will provide valuable lessons for advancing age-appropriate, career-driven, equitable AI learning for K-12 students at the AI era.

Pillar 1: Innovative Use of Technologies in Learning and Teaching
We will put the “Five Big Ideas in AI”, including perception, representation and reasoning, learning, natural interaction, and societal impact, into smart manufacturing and identify age-appropriate AI knowledge for high-school students. The AI learning modules include (1) perceiving the temperature and vibration, (2) representing operations with sensor data, (3) learning data patterns for different operations, (4) communicating operations with natural language, and (5) showing AI impacts on operations.

Pillar 2: Partnerships for Career and Workforce Preparation.
The recently emerging AI has prompted various industries to reimagine their work activities and reevaluate their requirements for the future workforce. Focused on underserved high schools and underrepresented students, this career-driven AI educational program will improve broader interest from diverse students in smart manufacturing and prepares underserved students to high-quality, higher-paying jobs in manufacturing, addressing the knowledge gaps and workforce shortage for smart manufacturing in the U.S.

Pillar 3: Strategies for Equity in STEM Education
This AI in smart manufacturing education program will employ project-based learning to stimulate broader career interest among a diverse range of students. Fifty rising high-school students from underserved school districts across the Black Belt region and rural low-income areas of Alabama will be recruited to participate in a one-week summer camp. Ten high-school teachers will be recruited to receive a three-day intensive professional training to continue the AI educational intervention at their respective schools.

Related ITEST Project:
A Career-Driven AI Educational Program in Smart Manufacturing for Underserved High-school Students in the Alabama Black Belt Region (Award# 2338987)

Principal Investigator(s):
Jia Liu (lzj0040@auburn.edu)

From Play to Problem-Solving: Augmented Reality for Enhancing Computational Thinking in Young Learners

This study introduces an innovative augmented reality (AR) environment, augmented by Linibot, a physical robot, to cultivate computational thinking skills in young learners. Integrating AR technology with Linibot, children navigate a grid-like environment on a tablet, guided by the robot through AR obstacles. The objectives include fostering STEM problem-solving, symbol comprehension, and confidence in technology. Pre- and post-tests evaluated the impact on computational thinking in the intervention group of thirty-five children across diverse settings, with a showcase event involving twenty children. Iteratively refined over two and a half years, ongoing analysis of interaction logs aims to assess performance and refine the environment. Preliminary results from five students show significant improvements in task performance, including a 42% decrease in task completion time, an 80% decrease in avoiding difficult problems, and an 80% increase in mission achievements. The tool not only enhances computational thinking but also influences learning behavior, encouraging students to tackle challenges. Future studies will compare control and intervention groups for a comprehensive understanding of the intervention's impact.

Related Links: (http://createcenter.net/imriel.php)

Target Gradespan(s): Early Childhood (PK) , Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI) , Research Study , Youth-Based
Discipline(s): Computer and informational technology science , Engineering , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Interdisciplinary
Geographic Location(s): Rural , Suburban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Our project pioneers the integration of augmented reality (AR) technology with a physically embodied robot, Linibot, to enhance early computational thinking skills in young learners. By immersing children in a dynamic AR environment, guided by Linibot, we revolutionize traditional learning methods, making abstract concepts tangible and engaging. Through this innovative approach, we create an interactive and immersive learning experience that fosters STEM problem-solving, symbol comprehension, and confidence in technolog

Pillar 2: Partnerships for Career and Workforce Preparation.
Our project collaborates with educational institutions and technology providers to prepare students for future careers. By integrating cutting-edge AR technology and robotics into early education, we bridge the gap between classroom learning and real-world applications. Through partnerships, we ensure alignment with educational needs, providing students with relevant skills and preparing them for success in STEM fields and the evolving workforce landscape.

Pillar 3: Strategies for Equity in STEM Education
Our project employs inclusive design principles and community engagement to promote equity in STEM education. We prioritize accessibility and representation, ensuring that our AR environment and Linibot platform are inclusive of diverse learners. By partnering with schools and organizations serving underrepresented communities, we aim to address systemic barriers and provide equal opportunities for all students to develop essential computational thinking skills, regardless of background or ability.

Related ITEST Project:
Supporting Early Learning of Computational Thinking Using Mixed Reality Technology (Award# 2048989, 2049046)

Principal Investigator(s):
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Co-Principal Investigator(s):
Thomas Brush, Jaejin Hwang

Growing STEM leaders through mentoring: Physical Computing and Automated Greenhouses

Central to our work is engaging high school as teachers, mentors, and role models who teach their younger peers in applying concepts and ideas from physics, plant science, engineering design, and coding to design and build a smart automated desktop-sized greenhouse. In the building of the greenhouse, youth use physical computing where they are learning how to connect coding to the physical world through microcontrollers by programing sensors to collect data and using that data to control devices such as fans, lights, and heaters to maintain appropriate environmental conditions for plants in their greenhouse. To program their greenhouse, students use MakeCode, a web-based block programming interface that connects directly to micro:bit, a powerful and low-cost microcontroller. To support the high school youth's interest in obtaining a post-secondary degree, they are mentored by first generation college students from Lasell University's “Pathways to Diversity” program. We focus our recruitment on youth who have been historically excluded from STEM fields and youth who do not have a particular interest in STEM. As such, another key aspect of our work is the longitudinal nature of our research. Our research has focused on student identity and interest development over time as we have been tracking the impact of participation in our programs as youth progress from participant, to teacher, to youth leader.

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Interdisciplinary
Geographic Location(s): Urban

Related Links: A core partner site: an unmaker community space (https://charlesrivercollab.org/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Physical computing supports student to become designers, not just users of technology, where they code to collect data and use that data to manipulate the real-world environment. Physical computing covers the design and realization of connecting the digital world to the real world and allows students to develop concrete, tangible artifacts and solutions that require integrated STEM practices where they are blending technological design, scientific investigation, and engineering design.

Pillar 2: Partnerships for Career and Workforce Preparation.
Culturallly sustaining pedagogy is a strengths-based approach that centers on learners and their communities and their diverse ways of knowing by empowering them to learn about their and others’ histories and cultures and drawing upon their own habits of mind and knowledge bases to discern meaning and purpose through their learning and interactions (King et al., 2023). In addition, for many youth, self-esteem and self-efficacy toward STEM are critical if they are to consider studying STEM in the future.

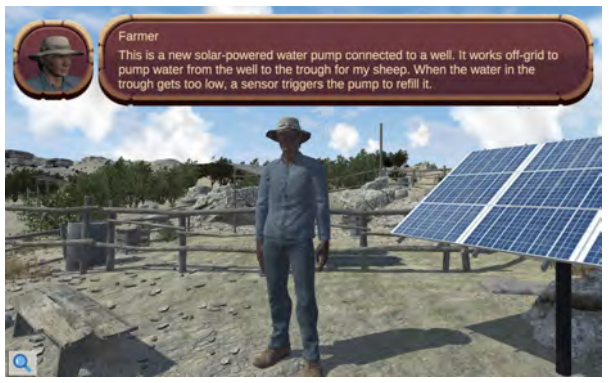
Pillar 3: Strategies for Equity in STEM Education
We use a three-pronged approach to support youth around career and workforce preparation. First youth are engaged in career exploration learning experience using our “Tools for Tomorrow” curriculum (Dr. Maureen Kenny) where youth explore their values, goals, and sense of purpose. Second, youth engage with mentors from Lasell University who are studying education and biotechnology. Third, youth engage in discussions with industry experts from 3D printing companies like Markforged.

Related ITEST Project:
Building a Youth-Led Learning Community through Automating Hydroponic Systems (Award# 2048994)

Principal Investigator(s):
Mike Barnett (barnetge@bc.edu)

Co-Principal Investigator(s):
Avneet Hira, Helen Zhang

Hybrid Immersive Learning Environments for the Diné



The mission of this ITEST Developing and Testing Innovations project is to explore the affordances of hybrid immersive learning environments situated in tribal contexts to engage Diné (Navajo) middle school students in place-based virtual scientific investigations and hands-on physical experiments and engineering design. This culturally responsive approach has the potential to inspire the next generation of Diné engineers and scientists to use their cultural and STEM knowledge to strengthen their communities and promote tribal sovereignty. Building upon prior NSF-funded work of PI Jordan and Co-PI Metcalf in partnership with the Ke'yah Advanced Rural Manufacturing Alliance (KARMA), the Department of Diné Education, and 7 Navajo Nation pilot schools, this project will result in the creation of two hybrid culturally-situated immersive learning environments for schools on the Navajo Nation centered around the past, present, and future of (1) energy (specifically the transition from coal to solar), and (2) water (both shortage and quality issues) in the Navajo Nation. This study will advance knowledge of blending virtual 3-D immersive learning environments with hands-on project-based learning, in culturally-situated contexts to support students to design energy and water futures. It will also generate new knowledge of how Diné cultural capital can be used in engineering design and intersect with STEM, & continue to evolve equitable community participatory research approaches.

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI) , Research Study , Youth-Based
Discipline(s): Engineering , Environmental sciences , Interdisciplinary
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The immersive virtual environment will support science investigation in the past and present through situated, place-based investigation, with connections to cultural and historical context, and visualizations not accessible in real world environments. The hands-on engineering design activity will involve culturally sustaining Diné engineering design activities to engage students in designing solutions in the present and for the future of energy and water on the Navajo Nation.

Pillar 2: Partnerships for Career and Workforce Preparation.
This study will directly impact 1800+ middle school students and 60+ teachers across 15+ schools across all 5 agencies of the Navajo Nation by providing opportunities to learn about the history and contemporary issues surrounding energy and water conservation affecting the future of their communities. A train-the-trainer (TTT) model for PD will be used to promote tribal sovereignty by building internal capacity to scale and sustain implementation of the curricula.

Pillar 3: Strategies for Equity in STEM Education
A Community Participatory Design-Based Research (CP-DBR) approach will be used to collaborate with Diné community members (including elders, leaders, teachers, and engineers) to co-design and improve the virtual environment, integrate Diné traditional ecological knowledge (TEK), hands-on engineering design curriculum, and teacher professional development. CP-DBR is a responsible and ethical data-driven process to collaborate with the Diné community on research that benefits both Diné and research communities.

Related ITEST Project:
Culturally situated immersive virtual learning and engineering design to build STEM capacity in Dine communities (Award# 2241802)

Principal Investigator(s):
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Co-Principal Investigator(s):
Shari Metcalf

ImageSTEAM: Middle School Teacher Professional Development in AI and Visual Computing through Computational Cameras

Artificial intelligence (AI) and its teaching in the K-12 grades has been championed as a vital need for the United States due to the technology's future prominence in the 21st century. However, there remain several barriers including the inter-disciplinary knowledge needed and the lack of formal training or preparation for teachers to implement these topics in middle school curriculum. We present ImageSTEAM, a teacher professional development for creating lessons for middle school grades 6-8 classes surrounding computer vision, machine learning, and computational cameras. Teacher professional development workshops were conducted in the states of Arizona and Georgia from 2021- 2023 where lessons were co-created with teachers to introduce various specific visual computing concepts while aligning to state and national standards. Results from the professional development workshops highlight key opportunities and challenges in integrating this content into the standard curriculum, the benefits of a co-creation pedagogy, and the positive impact on teacher and student's learning experiences. The open-source program curriculum is available at www.imagesteam.org.

Target Gradespan(s): Middle school (6-8)
Project Category: Conference/ Workshop
Discipline(s): Computer and informational technology science
Geographic Location(s): Rural , Suburban

Related Links: (https://www.imagesteam.org/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project's innovative technologies in learning and teaching include, pixlr, Google's Teachable Machine, Generative AI tools such as NVIDIA's GauGAN, Custom Google Colab Notebooks, and Tinkercad. The research team created a custom library in Python, lever- aging OpenCV and PyTorch, which can be imported directly from Github. Lessons were designed to integrate these activities directly to teach and deep students' understanding of key concepts surrounding pixels, color, image size, and machine learning.

Pillar 2: Partnerships for Career and Workforce Preparation.
We partnered with Title I schools for middle school teachers and students both in Georgia and Arizona for both career and workforce preparation.

Pillar 3: Strategies for Equity in STEM Education
As part of project's strategies for equity in STEM education, we recruited middle school teachers and students from Title I schools in Georgia specific districts for equity and inclusion. We found that both teachers and students actually found discussions around bias and ethics less intimidating than some of the more technical topics in AI/CV/ML, and were able to share their opinions more easily based on their own personal experience.

Related ITEST Project:
Middle School Teacher and Student's Experiences with Artificial Intelligence via Computational Cameras (Award# 1949493, 1949384)

Principal Investigator(s):
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Co-Principal Investigator(s):
Kimberlee Swisher, Terri Kurz, Wendy Barnard, John Mativo, Dawn Robinson

Informing the Future with Reflections on Prior ITEST-like Experiences by Current STEM Professionals

ITEST supports projects to build capacity and interest in STEM. By furnishing innovative experiences for teachers and students now, ITEST hopes to improve lives and the nation's STEM enterprise in the future. ITEST also supports one retrospective study to envision the future by informing from the past. It asks alums of an "ITEST-similar" program – NSF's 1990s era Young Scholars Program (YSP) – to reflect on how that NSF support shaped their future. How do their reflections inform ITEST PIs now? 1) The mysteries and beauty of STEM fields animate and enthuse adolescents when they animate and enthuse the project leaders. Make visible your love for your field– and your wonderment and surprise at it. 2) Most vivid memories a generation later? YSP alums cite social activities - game nights, trips to a baseball game, or the awe of being on a college campus. One alum, a prominent attorney, repeatedly used the term "holistic" to describe her experience. Be holistic in your projects! 3) YSP alums cite confidence-building as the most formative aspect of their YSP experience, and critical to building their sense of identity. 4) And the paths always change. Some of the students most sure about entering STEM fields took completely unexpected detours. But YSP helped build a foundation for resilience and for navigating early adulthood. May your ITEST projects do likewise!

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Exploring Theory and Design Principles (ETD) , Scaling, Expanding, and Iterating Innovations (SEI) , Synthesis , EAGER , Research Study
Discipline(s): Computer and informational technology science , Engineering , Interdisciplinary , Life sciences , Mathematical sciences , Physics and astronomy
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
As a retrospective effort, this project employs a recently emerging tool called epistemic network analysis (ENA) to help build richer understandings of the reflections that YSP alums shared. This is an advanced methodological tool that current ITEST projects are encouraged to explore. Experiences of the alums heavily involved innovative technologies of the 1990s!

Pillar 2: Partnerships for Career and Workforce Preparation.
As a retrospective effort, this project explores how the many partnerships at the time – and there were many across major technology firms, scientific laboratories, and universities – helped shape an awareness by participants of opportunities for STEM career pathways. At the time, field trips proved the most common form of partnership. They were eye-opening and contributed to the holistic approach of the program nationally.

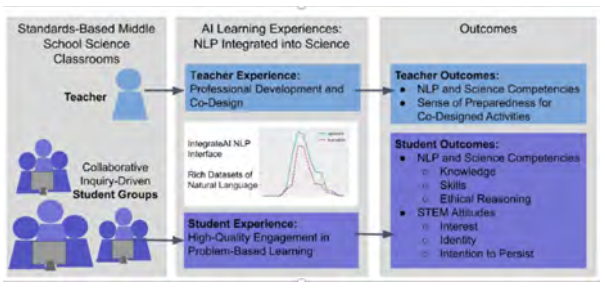
Pillar 3: Strategies for Equity in STEM Education
One aspect of this retrospective study involves documenting the many ways that faculty nationwide sought to insure and build equity. One principal strategy involved careful attention in recruiting in ways that actively sought to broaden participation in coming alongside STEM professionals, and actively promoted building a more inclusive STEM workforce. And, the holistic and asset-based approach of YSP PIs treated STEM fields as natural and accessible to middle and secondary students.

Related ITEST Project:
Peering a generation into the future: NSF's Young Scholars Program and the nation's STEM workforce (Award# 2109443)

Principal Investigator(s):
Eric Hamilton (eric.hamilton@pepperdine.edu)

IntegrateAI: Integrating AI Learning into Middle School Science through Natural Language Processing

Project IntegrateAI seeks to engage learners in authentic, inquiry-driven projects to investigate scientific questions using natural language data. • For students, we engage them in innovative Natural Language Processing (NLP) learning experiences to foster their knowledge and skills in NLP and science, improve their attitudes toward STEM careers (interest, identity, and intention to persist), and enhance their ethical reasoning. • For teachers, we assist them in developing AI learning competencies and enable them to feel prepared to integrate authentic, inquiry-based NLP experiences into their science classrooms. We have developed a novel platform for integrating NLP in middle-school science classrooms. Both teachers and students found the platform engaging and interactive. We developed an NLP+Science curriculum with nine middle-school science teachers during professional development workshops. We conducted classroom studies with 146 students in middle-school science classrooms in Florida and Indiana. We have published on this work and presented at major conferences such as ICLS, SIGCSE, and the International Conference of the Learning Sciences.



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Environmental sciences , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Suburban , Urban
Related Links: (https://www.integrateai-project.org/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Natural language data is everywhere: news articles, social media posts, YouTube transcripts, TikTok comments, and more. Large amounts of this data are related to scientific phenomena such as weather, health and diseases, engineering, and conservation. Our project leverages the power of artificial intelligence to process huge amounts of data in fractions of a second. This powerful field of artificial intelligence is called Natural Language Processing (NLP), and our project is applying it to middle-school science teaching

Pillar 2: Partnerships for Career and Workforce Preparation.
The Integrate AI Project is a partnership among the University of Florida, North Carolina State University, and Indiana University, carrying out a participatory co-design effort with teachers to develop an NLP+Science curriculum for middle-school students. This curriculum will increase students' knowledge and interest in STEM and ICT careers.

Pillar 3: Strategies for Equity in STEM Education
The research team will provide potentially transformative experiences to 12 teachers and over 1,000 students, leveraging existing partnerships within a multi-district, two-state effort in Florida and Indiana in diverse schools with approximately 50% African-American students and the majority of students eligible for free or reduced-price lunch.

Related ITEST Project:
Integrating AI Learning into Middle School Science through Natural Language Processing (Award# 2147810, 2147811)

Principal Investigator(s):
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Co-Principal Investigator(s):
Mehmet Celepkolu, Cindy Hmelo-Silver, Thomas Brush

Integrating AI Technical Learning with Ethics in an Online Collaborative Learning Environment

As AI becomes increasingly integral to a broad range of industries, it is critical that the field develops equitable and justice-oriented instructional models that can support youth to integrate technical knowledge about AI with ethical principles for AI development and deployment. This project will design and study an online course for high school aged youth that is a collaborative learning experience for building workforce skills. The project will strengthen and broaden youth capacity for, and disposition toward, artificial intelligence (AI) domains and careers. Learning activities will provide youth with opportunities to develop AI systems grounded in real-world contexts that are relevant to this age group including college applications, health care, and social media, enabling them to draw on their own personal and cultural knowledge. Through its implementation, the project will address three important national needs: (1) increasing and expanding AI workforce capacity; (2) attending to the social and ethical concerns associated with AI; and (3) broadening participation in AI understanding to bring a greater diversity of lived experiences to the AI workforce and greater STEM field.

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
This project will advance knowledge toward building a more inclusive approach to integrating ethical principles within technical training. This will increase the likelihood that the future workforce will be attentive to ethical concerns and better reflect the views and backgrounds of the populations that the technology is supposed to serve. Through the intentional design for productive online collaboration, the project will contribute to improved learning outcomes in online spaces.

Pillar 2: Partnerships for Career and Workforce Preparation.
Through its implementation, the project will address three important national needs: (1) increasing and expanding AI workforce capacity; (2) attending to the social and ethical concerns associated with AI; and (3) broadening participation in AI understanding to bring a greater diversity of lived experiences to the AI workforce and greater STEM field.

Pillar 3: Strategies for Equity in STEM Education
The project is engaging a youth advisory board and drawing on principles from Culturally Responsive Computing (Scott, Sheridan, and Clark, 2015) to ensure that learning activities are grounded in real-world contexts that are relevant to high school aged-youth and enables them to draw on their own personal and cultural knowledge.

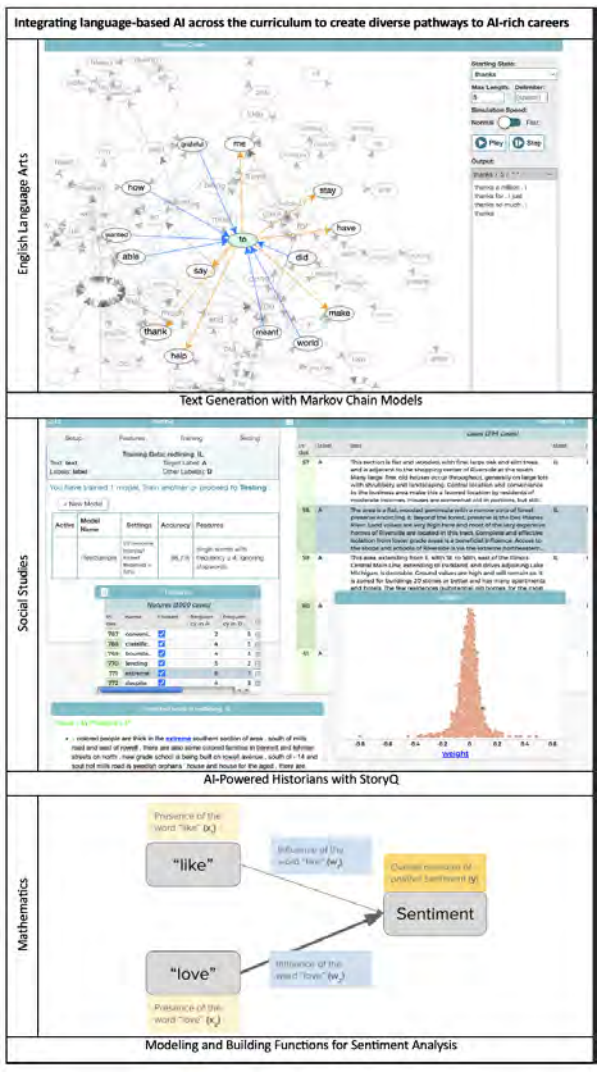
Related ITEST Project:
AI for the Workforce of Tomorrow: Attending to Ethics and Collaboration in Learning Artificial Intelligence for High School Aged Youth (Award# 2241576)

Principal Investigator(s):
Matthew Cannady (mcannady@berkeley.edu)

Integrating language-based AI across the curriculum to create diverse pathways to AI-rich careers

This three-year Developing and Testing Innovations project aims to support high school students to develop foundational knowledge in Artificial Intelligence (AI) and interest in AI-rich careers. Luckily AI is a highly interdisciplinary field and AI education can happen in a variety of settings. This project aims to integrate foundational AI education into disciplinary studies to reach students most underrepresented and underserved in the field. The project has the following objectives: (1) Refine two apps, the StoryQ app developed for students in grades 6-12 to learn machine learning with unstructured text data without coding, and Markov Chain modeling app to visually explain generative AI, and embed these into our curriculum. (2) Building on prior work, develop and test a set of culturally relevant curriculum modules for math (5 hours), ELA (5 hours), history (5 hours), plus an introductory module (2 hours). (3) Work with SJCOE, MCCE, school administrators, and teachers to co-develop and test a 60-hour professional development program to implement the curriculum modules. (4) Explore research questions to advance our knowledge of student learning and career interest development as well as teacher community formation in the AI domain. (5) Evaluate the project's success via a group of external Advisory Board members. (6) Strategically and broadly disseminate project materials to the field.

Related Links: (https://concord.org/our-work/research-projects/multidisciplinary-ai-education-with-storyq/)



Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Data Science , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Interdisciplinary , Mathematical sciences , Other
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project is refining the StoryQ app and developing a Markov Chain model app to help students visualize text classification and text generation AI models. The use of these models is integrated into secondary disciplinary courses for maximum access and relatability.

Pillar 2: Partnerships for Career and Workforce Preparation.
By leveraging the intrinsic connections between AI and disciplines already taught in schools, the project envisions a series of learning opportunities, presenting discipline-specific scenarios for students to dive deep into aspects of AI and to develop awareness and interest in various AI applications and careers.

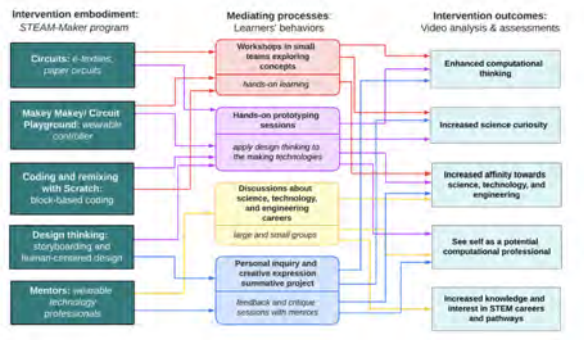
Pillar 3: Strategies for Equity in STEM Education
This project will create an effective, scalable, and sustainable exemplary program for high school students, especially those underrepresented and underserved in the field of AI, to develop foundational knowledge of AI and interest in AI-rich careers.

Related ITEST Project:
Integrating Language-Based AI Across the High School Curriculum to Create Diverse Pathways to AI-Rich Careers (Award# 2241669, 2241670, 2241671)

Principal Investigator(s):
Jie Chao, Shiyan Jiang, Carolyn Rose (jchao@concord.org)

Investigating the relationships among making, wearables, curiosity, computational thinking and STEM careers

This project focuses on youth-centered, culturally-relevant, out-of-school educational research and development. The team includes learning scientists and researchers, educators, directors and program administrators from Upward Bound and a makerspace/informal science institution, and engineering and wearable technology industry professionals. The STEM emphasis centers at the intersection of engineering and computational sciences, with content around coding digital technology and microcontrollers, and designing, developing and fabricating wearables and integrated systems. The project uses an iterative, design-based research methodology to lay the groundwork for design principles and empirical research findings on the relationships among curiosity, computational thinking, and STEM careers. It further provides feedback on how to foster equitable, out-of-school STEM secondary education, and informs broader STEM enrichment efforts at multiple Upward Bound sites nationally. The project has four objectives: (a) Testing and refining the STEM and arts-based curriculum, which includes hands-on, project-based activities; (b) Building design principles around the linkages between curiosity, computational thinking, and STEM careers; (c) Solidifying a research-practice partnership with learning scientists, educators, makerspaces, summer programs, and youth-serving organizations; and (d) Broadening underserved students' participation through summer camps and school-year activities.



Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Computer and informational technology science , Data Science , Engineering
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Our initial intervention includes: a) a curriculum that supports culturally-relevant and inclusive participation in e-textile making activities, and b) follow-up for participating high school students with interactions with engineering and scientists from wearable technology industries and academia. This two-year project will lay the groundwork for a revised summer camp curriculum, design principles, and empirical research findings on the relationships among curiosity, computational thinking, and STEM careers.

Pillar 2: Partnerships for Career and Workforce Preparation.
We will employ the multimodal framework to understand youths' computational thinking concepts, practices, perspectives, and self-perceptions, and triangulate these results to youths' measures on the science curiosity scale and STEM Career Interest Survey score. Recent CS and engineering graduates will serve as mentors. Near- peer mentoring) has been successfully applied in many informal STEM learning environments (Ross et al., 2018; Salzman & Strobel, 2011; Tenenbaum et al., 2014).

Pillar 3: Strategies for Equity in STEM Education
Our broader impacts and strategies for STEM educational equity include: (a) Addressing historic underrepresentation of low income and minoritized racial/ethnic youth in STEM through research-practice partnerships across Upward Bound sites; (b) Supporting iterative research on how science curiosity, STEM career interest, and computational thinking manifest in and can be enhanced through culturally-situated approaches; and (c) Augmenting research and practice through the development of design principles.

Related ITEST Project:
Collaborative Research: Exploring Theory and Design Principles (ETD): Investigating the relationships among making, wearables, curiosity, computational thinking and STEM careers (Award# 2241700, 2241701)

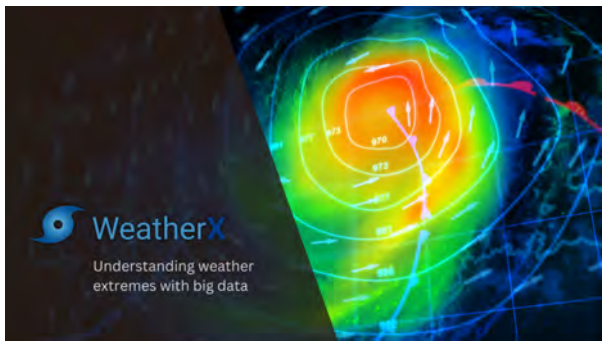
Principal Investigator(s):
Heather Zimmerman (haz2@psu.edu)

Co-Principal Investigator(s):
Gabriela Richard, Jennifer Weible

Learning about big weather with big data

The WeatherX project developed and has been studying multi-week curriculum units for middle-school science classes to promote understanding of and interests in fundamental data practices and scientific data careers among students in low-income rural communities. Using WeatherX materials, students work with large-scale data to investigate typical and extreme weather in their local areas and on New Hampshire's Mount Washington – a place nicknamed "The Home of the World's Worst Weather." The project has been led by researchers and developers at Education Development Center, the Mount Washington Observatory, the University of Maine at Orono, the University of Washington in Seattle, and the Concord Consortium, and it has collaborated with 12 teachers and over 470 students in rural New Hampshire and Maine.

Related Links: (https://sites.google.com/view/edcweatherx/home)



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI) , Strategies
Discipline(s): Data Science , Environmental sciences
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
WeatherX has developed an online portal that provides access to current and historic large-scale weather data from the National Oceanographic and Atmospheric Administration (NOAA) for almost 1,800 weather stations across the U.S. The portal is freely available to the world as a plug-in within the Common Online Data Analysis Program (CODAP), the online data analysis and visualization tool that students use to investigate local and Mount Washington weather data.

Pillar 2: Partnerships for Career and Workforce Preparation.
As a key project partner, the Mount Washington Observatory (MWOBS) helped the project develop and study Chat with a Scientist experiences, in which students in participating WeatherX classrooms connected through a live video connection with weather scientists who work and live on the summit of Mount Washington. Typically lasting 30 to 50 minutes, the Chats followed a question-and-answer format, in which students could ask questions about scientists' work and personal interests as well as about weather and climate.

Pillar 3: Strategies for Equity in STEM Education
WeatherX has focused on serving low-income rural communities in NH and ME. Following a place-based learning strategy, students learned to graph and analyze large-scale weather data from their local area and Mount Washington. Students tapped into the cultural wealth of their communities by interviewing community members about their experiences with weather. Students also learned about careers in their area that use weather data.

Related ITEST Project:
Understanding Weather Extremes with Big Data: Inspiring Rural Youth in Data Science (Award# 1850447)

Principal Investigator(s):
Josephine Louie (jlouie@edc.org)

Co-Principal Investigator(s):
Emily Fagan, Brian Fitzgerald, Kevin Waterman

Learning from the community to understand layers of trauma and apply trauma-informed STEM education as a tool to support processing, recovery, and healing

Natural disasters have increased significantly over the past few decades. The UN has released a study that the number of wildfires is expected to rise by 50% by 2100 (United Nations Environment Programe, 2022). The most recent example of this is the Hawaiian island community of Maui. As residents and STEM educators in the State of Hawai'i with rich and deep roots in communities on Maui, we apply the STEMS2 (Science, Technology, Engineering, Mathematics, Social Sciences and Sense of Place) Framework (O'Neill et al., 2023) to map the multiple layers of trauma from these wildfires and explore how trauma-informed STEM education might serve as a tool to support processing, recovery, and healing. project will consist of three iterative phases. The primary focus of this RAPID project is Phase 1. Engaging with our well-established networks within the community, Phase 1 focused on conducting a series of semi-structured interviews, focus groups, and talk-story interviews (O'Neill et al., 2023) using snowball sampling (Parker et al., 2019). The primary goal of Phase 1 is to learn from educators and students in the community and determine the layers of trauma present as a result of their wildfire experiences and needs in reaction to STEM education. Lessons learned in Phase 1 will inform the intervention design phase (Phase 2) and the implementation phase (Phase 3) as appropriate based on community invitation and needs.

Target Gradespan(s): Elementary school (K-5) , Middle school (6-8) , High school (9-12)
Project Category: Exploratory
Discipline(s): Interdisciplinary
Geographic Location(s): Rural , Suburban , Urban

Related Links: (https://coe.hawaii.edu/stems2/programs/masters/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The innovation in this work is intentionally applying a trauma-informed approach in learning and teaching with technologies such as robots. This approach enhances student safety and well-being. It acknowledges the impact of trauma on learning, fosters a supportive environment, and uses digital tools to create safe, inclusive educational experiences that prevent retraumatization

Pillar 2: Partnerships for Career and Workforce Preparation.
The focus of this work is on learning how to build trauma-informed STEM learning environments. Part of this process has required leading from student wonder rather than centering career and workforce preparation.

Pillar 3: Strategies for Equity in STEM Education
Creating safe and supportive learning environments is key - helping educators recognize and respond to the impact of trauma on students, fostering a sense of safety and belonging in STEM learning. Addressing barriers to STEM access is also crucial, as understanding the effects of trauma allows educators to provide accommodations and targeted support to help students overcome obstacles and participate. Diversifying STEM role models is important too, such as highlighting diversity by having youth work collaboratively with

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Related ITEST Project:
Learning from the Maui community to understand layers of trauma and trauma-informed STEM education as a tool to support processing, recovery, and healing (Award# 2345383)

Principal Investigator(s):
Tara O'Neill (toneill@hawaii.edu)

Making Mentors

This project pairs autistic college mentors with autistic high school mentees in New York City to create interest-based STEAM projects. In this way, the mentors can engage with the high school students by helping with their projects, learning what they care about and who they are as people, and then give tailored advice about the high school to college transition, support services, academic courses, and extracurricular activities that align with the mentee's strengths and interests. We use a co-design approach in which the mentors, mentees and high school educators determine how the program is designed. This project is a collaboration among Education Development Center, New York University and City University of New York (CUNY) Staten Island.

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The mentors and mentees often work on technology-based projects. Some examples from this year include a computer-aided design of houses that were 3D printed, a digital anime story, a photo journal of city scenes and a song created with audio software.

Pillar 2: Partnerships for Career and Workforce Preparation.
We are partnering with universities that have autism support programs as well as career support services and high school autism support and college counselors. Mentors are trained by NYU's Wasserman Center for Career Development.

Pillar 3: Strategies for Equity in STEM Education
We are working with autism support programs in New York City public schools and at the universities. All mentors and mentees identify as autistic. We are working with NYC public high schools that serve autistic students with a range of support needs and which serve a diverse student population. Our mentors are able to self identify as neurodivergent, which enables people who are less likely to have a formal diagnosis (women, non-binary, Black, Hispanic, low-income) to be represented in the mentor group.

Related ITEST Project:
Making Mentors: Enhancing Access to STEM Careers for Autistic Youth through Mentorship Programs in Makerspaces
(Award# 2241350)

Principal Investigator(s):
Wendy Martin (wmartin@edc.org)

Making Waves with Radio: Empowering Informal STEM Educators

Wireless radio communications, such as Wi-Fi, transmit public and private data from one device to another, including cell phones, computers, medical equipment, satellites, space rockets, and air traffic control. Despite their critical role and prevalence, many people are unfamiliar with radio waves, how they are generated and interact with their surroundings, and why they are the basis of modern communication and navigation. Making Waves with Radio has created a series of hands-on activities and professional resources to assist educators in presenting these topics to diverse audiences.

MAKING WAVES
with radio

Related Links: Radio learning resources on the NISENet site (http://nisenet.org/radio),What is radio? (https://vimeo.com/776685410),Qué es la Radio? (https://vimeo.com/776686149)

Target Gradespan(s): Other
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Physics and astronomy

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Hands-on activities include a training video and materials in Spanish. Two of the activities also use a mobile app to assist learners. This downloadable kit of hands-on activities help learners explore the phenomena, uses, and societal impact of radio technologies using everyday materials to engage in hands-on experimentation with radio waves. Youth use the BBC micro:bit and the Teknikio Bluebird to design a solution to a community-based problem. A mobile app story shares about radio communications during a hurricane.

Pillar 2: Partnerships for Career and Workforce Preparation.
To support informal STEM educators, we partner with science centers, museums, & community-based organizations: the Children's Creativity Museum, Museum of Life and Science, Explora, Sciencenter, El Centro Hispano, El Futuro, and the Global Alliance for Community Science Workshops. A community of practice (CoP) serving Latiné families was also convened for professional learning: Arecibo Observatory, Brownsville Museum, Columbia Memorial Space Center, Corpus Christi Museum, Explora, and Children's Museum of Brownsville.

Pillar 3: Strategies for Equity in STEM Education
Our team has used the following strategies to support equity in design: Codesign with educators, youth and radio engineering experts to ensure inclusive and culturally responsive materials; Design for a range of modalities to demystify radio communications, and the systems and values involved; Support a CoP and in partnership with Latiné-serving organizations who work closely with youth and families; Leverage long-standing national dissemination networks to reach a diverse set of learners, educators, and communities.

Related ITEST Project:
Empowering Informal Educators to Prepare Future Generations in Wireless Radio Communications with Mobile Resources (Award# 2053160, 2005784)

Principal Investigator(s):
Sherry Hsi (shsi@bscs.org)

Co-Principal Investigator(s):
Darrell Porcello, Hyunjoo Oh

Mixed Reality Based Interactive Cybersecurity Education for Middle School Students

Our project addresses the critical shortage of skilled cybersecurity professionals and the lack of diversity in the field, highlighted by a projected 31% increase in information security analyst roles from 2019 to 2029 (U.S. Bureau of Labor Statistics) and a tripling in the demand for cybersecurity roles since 2013 (Burning Glass). We aim to spark interest in cybersecurity careers through mixed-reality (MR) learning activities for middle school students, focusing on foundational cybersecurity concepts. Our interdisciplinary team from the University of Delaware collaborates with local schools and the state chapter of the Computer Science Teachers Association. We're developing MR modules on topics like steganography, phishing, and firewalls, refined through an iterative design process and classroom implementation in a pre/post-test study format. Significant progress includes the development of an augmented reality (AR) game about firewalls and a storyboard for a phishing game, informed by teacher feedback. A hackathon involving 17 undergraduate CS students created prototypes, integrating technology and educational design. This project aligns with the National Science Foundation's mission by promoting STEM education and aiming to expand the cybersecurity workforce, particularly among underrepresented groups. Through these innovative educational tools, we aspire to cultivate a diverse new generation of cybersecurity professionals.

Target Gradespan(s): Middle school (6-8)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Computer and informational technology science

Related Links: (https://sites.udel.edu/itest-cice/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project innovatively employs mixed-reality (MR) and augmented reality (AR) technologies to teach cybersecurity to middle school students. We develop engaging, interactive MR activities on topics like firewalls, phishing, and steganography. These tools are designed to enhance learning through immersive experiences, making complex subjects accessible and exciting. Our AR game prototypes, developed through hackathons, further demonstrate practical applications of emerging technologies in educational settings.

Pillar 2: Partnerships for Career and Workforce Preparation.
The project collaborates with the University of Delaware, local schools, and the state chapter of the Computer Science Teachers Association. This partnership fosters direct engagement with educational stakeholders to tailor MR and AR learning tools for early career exploration in cybersecurity. We also integrate feedback from educators and students in the design process, ensuring our outputs align closely with real-world workforce requirements and enhance career readiness in STEM fields.

Pillar 3: Strategies for Equity in STEM Education
Our project enhances equity in STEM by integrating teacher insights into the development of MR and AR tools, ensuring relevance for a diverse student base. By enabling group play on single tablets, we improve access in under-resourced classrooms. Our games feature varied conceptual representations to cater to different learning styles and interests, making cybersecurity education accessible and engaging for all students, thereby encouraging a wider array of young learners to explore STEM careers.

Related ITEST Project:
Mixed Reality Based Interactive Cybersecurity Education for Middle School Students (Award# 2048874)

Principal Investigator(s):
Chien-Chung Shen (cshen@udel.edu)

Molly Community Science: Supporting Science Exploration and Environmental Identity Development with PBS KIDS' Molly of Denali

Molly Community Science aims to support science exploration and environmental identity development among 6- to 8-year-old children from rural Alaska Native communities. The project has two goals: (1) to learn more about how children develop environmental identity (which we define as the empathy, knowledge, and skills needed to act responsibly for the environment); and (2) to co-design, with three Alaska Native villages, an intergenerational, community-based science program that nurtures children's environmental identity. The project builds on Molly of Denali, a national, animated PBS KIDS series that features an Alaska Native lead character; involves Alaska Native people at every level of production; and teaches literacy, social studies, Alaska Native values, and environmental science. Media producers at GBH (Boston's PBS station) are facilitating the development of the program, including the implementation model, curriculum, and supporting media and technology. Researchers at South Dakota State University and University of Alaska Southeast are investigating how children experience their place, and how the new community science program can contribute to environmental identity development. Educators at Association of Interior Native Educators are working with GBH to facilitate the creation of the community science program, including guiding our co-design work with three partner communities: Bethel, Hoonah, and Northway. Goldstream Group is serving as process evaluator.

Target Gradespan(s): Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Environmental sciences
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
In rural Alaska, cutting-edge media technologies can be expensive and challenging to implement without reliable internet access. Instead, our project incorporates innovative uses of more established media. We are creating Molly of Denali animations that show characters exploring nature using observation tools like field journals and hand lenses; live-action video that highlights scientists and Elders working together to care for the environment; and a mobile app that helps children illustrate and narrate their learning.

Pillar 2: Partnerships for Career and Workforce Preparation.
Informed by research findings, our project is working closely with three rural Alaska Native communities—Bethel, Hoonah, and Northway—to co-create and test the community science program and supporting media resources. This is being done in collaboration with a community liaison and a co-design team (made up of parents, educators, Elders, scientists, and culture bearers) in each community. Public media stations AKPM and KUAC are also assisting with the development of the program and sharing information about the project.

Pillar 3: Strategies for Equity in STEM Education
Alaska Native communities possess vast environmental science knowledge, yet Alaska Native people are underrepresented in STEM fields. Building on research that links environmental identity with pursuit of science careers, our project takes an assets-based, culturally responsive approach in order to create a community science program that helps children develop a stronger affinity for science while validating and celebrating their personal environmental and cultural identities.

Related ITEST Project:
Investigating environmental identity development among children in rural Alaska Native communities through intergenerational, culturally responsive community science programming (Award# 2049767)

Principal Investigator(s):
Jessica Andrews (jessica_andrews@wgbh.org)

Narrative Modeling with StoryQ - Linking AI, Language, and Science

As artificial intelligence (AI) transforms our society, it is essential for students to understand its mechanics, how machines learn from data, and the role of humans from diverse backgrounds and expertise in shaping AI. While computer science standards and organizations have emerged with commendable approaches, they often relegate experiences to self-selecting students who already show interest in the topic, and most students remain unaware of how AI is reshaping their future. Further, the AI workforce suffers from a severe lack of diversity. The StoryQ project brings innovative curricula and technology to equip students from diverse backgrounds to envision future careers in this new AI-driven workforce. By embedding AI education within a narrative context, StoryQ makes complex topics like machine learning more relatable and easier to understand. The platform encourages students to bring their own cultural and personal perspectives into their learning, allowing them to craft stories that reflect their identities while exploring AI technologies. This approach teaches technical skills while emphasizing the human aspects of AI development, including the ethical dimensions and the importance of diverse perspectives in shaping these technologies. StoryQ has been developed through a collaboration between the Concord Consortium, Carnegie Mellon University, and North Carolina State University, ensuring a robust and research-backed educational tool.

Related Links: (https://learn.concord.org/storyq)

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Data Science , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Mathematical sciences , Other
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
StoryQ is a web-based tool that integrates text mining with narrative modeling to teach artificial intelligence (AI) concepts. Requiring no local installation, it enables students to access and use it from any internet-connected computer. The activities blend traditional subjects such as mathematics and language arts with computing, making AI accessible and relatable.

Pillar 2: Partnerships for Career and Workforce Preparation.
This project advances STEM and ICT workforce development, emphasizing AI's impact on future careers. By partnering with educational institutions and industry leaders, we create authentic learning environments where high school students explore AI through text mining, developing essential skills for tech-driven careers. Our collaborative efforts involve designing research-based curricula that integrate real-world AI applications, ensuring students are well-prepared for a technology-centric workforce.

Pillar 3: Strategies for Equity in STEM Education
Our project prioritizes equity in STEM by tailoring the StoryQ curriculum to meet the needs of underrepresented groups. Through partnerships with community organizations and teachers, we ensure our AI tools and content are widely accessible and engaging. Our approach includes targeted recruitment, inclusive teaching methods, and culturally relevant curricula, all designed to empower a diverse student body to explore AI-driven careers.

Related ITEST Project:
Narrative Modeling with StoryQ: Integrating Mathematics, Language Arts, and Computing to Create Pathways to Artificial Intelligence Careers (Award# 1949110)

Principal Investigator(s):
Jie Chao (jchao@concord.org)

Co-Principal Investigator(s):
Shiyan Jiang

Native American Middle-school Students Afterschool STEM (NAMSAS) program

The project developed an after-school program aimed at boosting the STEM career interests of Native American middle-school students. Leveraging digital technologies like virtual reality (VR), augmented reality (AR), and 3D printing, students tackled spatial design challenges through culturally responsive modules. A co-design process with educators, community members, and students helped integrate cultural knowledge into learning environments relevant to Native American youth. The program targeted middle-school students and educators from three Tribal Nations in Oklahoma—Citizen Potawatomi, Otoe-Missouria, and Ponca—and enhanced the infrastructure for STEM education through technology centers and community-focused hackathons. Research on the program assessed its impact on students' STEM identities and career interests using mixed methods. This included observations, focus groups, and both qualitative and quantitative analyses. Findings, resources, and a digital repository were made available online, supporting other Tribal Nations and educators. The insights gained underscored the effectiveness of culturally responsive, community-co-created educational programs.

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Other
Geographic Location(s): Rural , Suburban

Related Links: Project Website (https://www.namsas.net)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project utilized VR and AR for immersive learning and 3D printing to materialize students' designs, enhancing their spatial understanding and creativity. A co-design process involving educators, community members, and students ensured culturally relevant content. Community-defined hackathons with these technologies promoted engagement and practical application, making the program a model of innovation in STEM education for Native American youth.

Pillar 2: Partnerships for Career and Workforce Preparation.
The project partnered with three Tribal Nations and after-school educators in Oklahoma, integrating cultural knowledge into STEM education. It offered professional development for educators on using VR, AR, and 3D printing, ensuring effective teaching of these technologies. Community-defined hackathons engaged students and families, highlighting practical tech applications and fostering interest in STEM careers. These partnerships enhanced career preparation and workforce readiness among Native American youth.

Pillar 3: Strategies for Equity in STEM Education
The project promoted equity in STEM by developing a culturally responsive curriculum and integrating advanced technologies like VR, AR, and 3D printing to engage Native American students. It included community and family in learning, offered targeted professional development for educators, and continuously adapted teaching methods. These strategies ensured inclusive education, reflecting students' cultural heritage while equipping them with relevant skills for future careers in STEM.

Related ITEST Project:
Engaging Native American Students in STEM Career Development Through a Culturally-Responsive After-School Program Using Virtual Environments and 3-D Printing (Award# 2048987)

Principal Investigator(s):
Tilanka Chandrasekera (tilanka@okstate.edu)

Co-Principal Investigator(s):
Nicole Colston

Neuroscience for Neurodiverse Learners (NNL)

Neuroscience for Neurodiverse Learners (NNL), provides hands-on experiences in neuroscience disciplines, networking opportunities, and resources to high school and early postsecondary students identified as neurodiverse learners—those with academic challenges related to conditions such as dyspraxia, dyslexia, attention deficit hyperactivity disorder, dyscalculia, autism spectrum disorder, and Tourette syndrome—and disseminates findings to teachers of courses that are related to neuroscience and, more broadly, science, technology, engineering, and mathematics (STEM). Led by the UW's Disabilities, Opportunities, Internetworking, and Technology (DO-IT) Center and Center for Neurotechnology (CNT), the goal of NNL is to enhance student interest in and skills to successfully pursue STEM fields, as well as empower educators to serve these students more effectively. Grounded in theory and research, the project takes a student-centered approach that embraces cutting-edge neuroscience, the social model of disability, social justice education, disability as a diversity issue, universal design, and a multi-faceted view of student engagement and retention.

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Other
Geographic Location(s): Suburban , Urban

Related Links: Neuroscience for Neurodiverse Learners (NNL) (https://www.washington.edu/doit/programs/nnl)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Researchers at the UW's Center for Neurotechnology, one of the project partners, are leaders in computational analysis, human-computer interfaces, wireless power, and other exciting innovations that have the potential to improve the lives of individuals who have been injured through accidents, stroke, or disease. These emerging technologies are incorporated into hands-on, inquiry-based activities and cooperative learning opportunities for neurodiverse students.

Pillar 2: Partnerships for Career and Workforce Preparation.
The NNL project is led by the UW's Disabilities, Opportunities, Internetworking, and Technology (DO-IT) Center and the Center for Neurotechnology (CNT). DO-IT has experience in developing hands-on programs for youth with disabilities, while the CNT boasts world-class research and a highly-rated, innovative neuroscience education program. The project incorporates cutting-edge neuroscience into activities designed to educate students about pursuing degrees and careers in neuroscience and other STEM fields.

Pillar 3: Strategies for Equity in STEM Education
NNL deploys key interventions for bringing students from underrepresented groups into STEM fields. These include hands-on experiences, work-based learning, research opportunities, real-world experiences, mentoring for students, and training for educators. Project interventions have been intentionally designed to address challenges often faced by neurodiverse STEM learners and workers. Participation in program activities encourages neurodiverse students to pursue neuroscience, and more broadly, STEM careers.

Related ITEST Project:
Neuroscience for Neurodiverse Learners (Award# 1948591)

Principal Investigator(s):
Scott Bellman (swb3@uw.edu)

NeuroVivid: A BCI Experience for Neurodivergent Youth

The NeuroVivid project is developing an innovative maker curriculum aimed at strengthening and broadening the talent pool of the future STEM workforce. NeuroVivid empowers a middle-school aged neurodiverse student population from a variety of ethnic and cultural backgrounds by helping them build their own simple EEG circuits to understand and interact with their brain activity. The project leverages low cost simple BCI tools to design an adaptable BCI experience in makerspaces to increase interest in STEM among a broad range of learners. NeuroVivid is being co-designed and tested using a design research approach with neurodivergent youth and makerspace facilitators. All content and activities are co-designed with stakeholders to ensure their voices are represented at all stages of the project. This project is advancing practice in makerspaces through generating knowledge about how these spaces can more explicitly affirm a broader range of cognitive strengths, while increasing neurodivergent youths' interest in the STEM careers of the future. The project pays particular attention to the intersectionality of neurodiversity with race, gender, and SES. The NeuroVivid maker curriculum can as a result serve as a model for creating more inclusive STEM maker experiences by identifying barriers to inclusion and how to overcome them.

Related Links: Project Website (https://www.terc.edu/projects/neurovivid/)

Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI) , Youth-Based
Discipline(s): Interdisciplinary
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
NeuroVivid uses simple BCI headsets, Arduinos, and block coding to help neurodivergent youth develop interest in BCI. Participants develop a range of relevant tech skills including coding and circuit building. In addition, participants learn the basic of neuroscience and develop a burgeoning understanding of the brain.

Pillar 2: Partnerships for Career and Workforce Preparation.
NeuroVivid is partnering with the New York Hall of Science and EDC to run a NeuroVivid camp for neurodivergent youth. The camp aims to introduce middle school aged youth to the basic skills and topics necessary to consider a future career in BCI. NeuroVivid also highlights diverse BCI professionals and provides training opportunities for neurodivergent co-designers.

Pillar 3: Strategies for Equity in STEM Education
NeuroVivid promotes equity by specifically developing and targeting its workshop at neurodivergent youth with particular attention to the intersectionality of participant identities. Work is supported by co-designing with neurodivergent youth from diverse backgrounds to ensure that all project activities are guided by stakeholders.

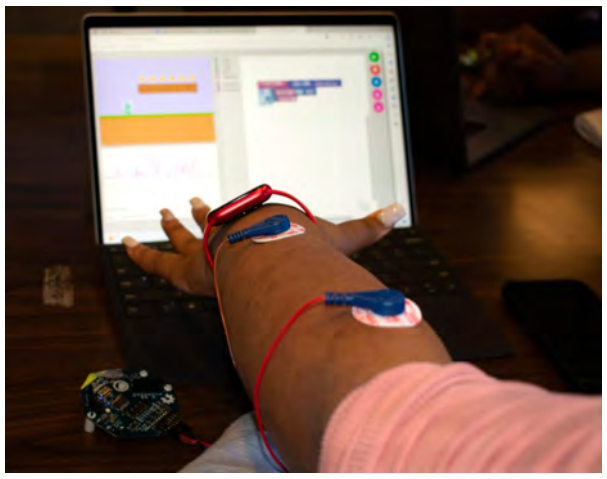
Related ITEST Project:
NeuroVivid: Developing and Testing a Maker Experience to Build Interest in Careers in Brain-Computer Interfaces Among Neurodivergent Youth (Award# 2241380)

Principal Investigator(s):
Ibrahim Dahlstrom-Hakki (idahlstromhakki@terc.edu)

Next Generation Physiological Interfaces

Relatively little research exists on the use of experiences with physiological sensors to support STEM education. In this work, we draw on techniques from physiological computing and computer science education to explore novel ways to build students' computational thinking skills. Learning barriers related to physiological expressions and physiological design may be less common with EMG-based (muscle) activities in comparison to EEG (brain) activities. Physiological design events seem to be highly connected with the "incremental & iterative" computational practice.

Related Links: (https://htilua.org/neuroblock)



Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
This project explores novel technologies such as brain and muscle sensors. These sensors are paired with visual programming environments to provide students with hands-on experiences with measuring electrophysiological data. Students also design simple real-time muscle- and brain-computer interfaces.

Pillar 2: Partnerships for Career and Workforce Preparation.
This project involves partnering with collaborators from the University of Alabama's School of Nursing to explore ways to build a pipeline of medical professionals from rural Alabama.

Pillar 3: Strategies for Equity in STEM Education
This project focuses on engaging students from rural Alabama with novel interactive sensor-based technologies.

Related ITEST Project:
CAREER: Engaging Rural Students with Next Generation Physiological Interfaces (Award# 2045561)

Principal Investigator(s):
Chris Crawford (crawford@cs.ua.edu)

Place-based Education in a Drone Related Co-production Project for Alaska Native Learners

This project uses tech and a place-based, community-engaged approach to examine attitudes toward STEM. Initially focused on student, teacher and community attitudes and behaviors, pandemic-related timeline and implementation adjustments provided an opportunity to also examine how we engaged with each other and with community members in three rural Alaska sites. Questions: How does a place-based STEM curriculum engage students, educators and communities to envision/apply STEM in different contexts? (a) How does training & collaboration develop educator competence/confidence in developing a culturally responsive STEM praxis? (b) How do Elders & communities exercise self-determination and ethos of place-based education in guiding project-based STEM curriculum development? c) How do interdisciplinary teams collaborate, communicate, and learn from one another when working on a community engagement project? Conclusion: Alaska is a rich context for place-based interventions. However, care must be taken throughout the life of a project to ensure community perspectives and concerns are identified, acknowledged and prioritized. Observations and interviews with participants have led to improved understandings about the value of authenticity in teamwork; how students and their teachers respond to place-based, technology-rich programs; and how Indigenous and rural communities embrace projects blending local knowledge and university science through co-production methods.

Related Links: DRONES project website. (https://sites.google.com/alaska.edu/drones)

Target Gradespan(s): Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI) , Exploring Theory and Design Principles (ETD) , Scaling, Expanding, and Iterating Innovations (SEI) , Strategies
Discipline(s): Environmental sciences , Geosciences , Interdisciplinary , Life sciences
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Students apply drone technology in understanding issues of local importance to the Tribe and the community.

Pillar 2: Partnerships for Career and Workforce Preparation.
Community partners participate in career explorations and visit classrooms to discuss how drones are used locally, and to share information about drone-related jobs.

Pillar 3: Strategies for Equity in STEM Education
Tribal priorities, approvals were foregrounded throughout the process; work was always and only done in full collaboration with Tribes. Local advisors chosen by the Tribe were interviewed, their wisdom was included in products. Products were developed and revised iteratively in collaboration with community, not published until approved by local advisors. Cultural values were identified, practices were respected, language was included. Local, cultural and university science were interwoven as complementary data.

Related ITEST Project:
Drone Research and Opportunities for Native Elementary Students (DRONES) (Award# 1850561, 1850556)

Principal Investigator(s):
Lynda McGilvary, Dayna DeFeo (lmmcgilvary@alaska.edu)

Preschoolers' Spatial Orientation Learning

This project provides direct student learning opportunities to foster preschoolers' spatial learning and STEM identity, particularly for underrepresented and underserved groups, by developing and researching a preschool mathematics curriculum supplement that leverages digital touch-screen tablets and Augmented Reality technologies. Spatial thinking, which includes spatial orientation, is often ignored in formal education settings during the early years. This is a significant curricular limitation, given that recent evidence links spatial thinking to readiness for kindergarten, readiness in mathematics, and it "may create a cascade of effects" on later mathematics skills. To help start this upward cascade, our team developed and tested a preschool classroom module and connected family resources that include hands-on activities, an existing tablet-based individual game, and an Augmented Reality app based on spatial orientation learning goals. The intervention included a Teacher's Guide to support educators and Family Guide to support caregivers in implementing in school and home environments. Our project used a a design-based research approach, to iteratively develop and test the intervention directly with preschool children (4-5-year-olds) from predominantly low-income and underserved backgrounds. These studies measured cognitive (e.g., spatial orientation learning) and social (STEM Identities) outcomes from an intervention that leverages "cutting-edge" AR technology in both

Target Gradespan(s): Early Childhood (PK)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Mathematical sciences

Related Links: Teacher Guide (https://first8studios.org/gracieandfriends/guide/spatial/),Family Guide (https://first8studios.org/gracieandfriends/family/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Augmented Reality (AR) integrates the real world with virtual content that is student-centered and playfully interactive. The project developed and tested an intervention that includes: a new AR app and an existing tablet game, spatial orientation activities for preschool classrooms that integrate learning opportunities with the apps, hands-on activities, and books; a digital teacher's guide and professional development resources; and a family guide for caregivers to foster preschoolers' spatial learning at home.

Pillar 2: Partnerships for Career and Workforce Preparation.
Research suggests that children naturally begin developing spatial skills by preschool, yet spatial skills receive minimal curricular focus and there is a dearth of relevant classroom and home activities for this age group. Well-designed early learning experiences are thus ripe opportunities to cultivate children's emerging spatial skills and AR is a novel approach therein. The broader goals are to improve spatial skills that prepare preschoolers for mathematics in K-12 schooling and engagement in STEM careers.

Pillar 3: Strategies for Equity in STEM Education
There is growing consensus that high-quality STEM education is critical for young children, particularly as a way to promote equity (Clements et al., 2020). Our innovative approach seeks to build on the research that preschool mathematics knowledge is a strong predictor of children's later academic success, that spatial learning has a unique contribution to make in later STEM engagement, and that developmentally appropriate preschool mathematics experiences hold exceptional promise to address educational inequities.

Related ITEST Project:
Transforming Preschoolers' Spatial Orientation: Leveraging New Technologies for Learning in Early Childhood Classrooms and at Home (Award# 2048883)

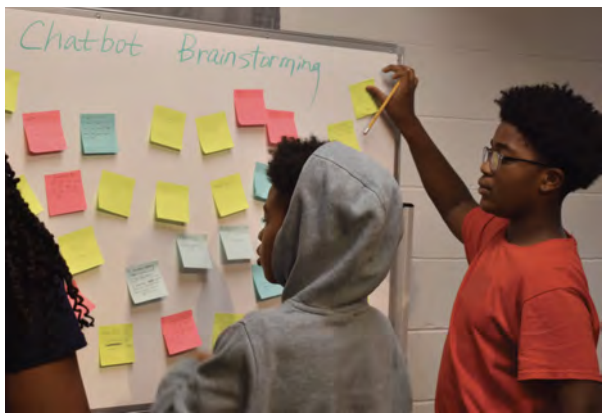
Principal Investigator(s):
Ashley Lewis Presser (alewis@edc.org)

Co-Principal Investigator(s):
Jillian Orr

Project DIALOGS: Fostering STEM Career Identity and Computer Science Learning through Youth-Led Conversational App Development Experiences

Project DIALOGS provides technology-rich learning opportunities for middle-school students to design and develop spoken conversational apps using computer science and artificial intelligence. Some 210 students from diverse, underserved schools with previously limited access to AI and computer science engaged in 2-week summer experiences to learn computer science and conversational AI development. Researchers in computer science and educational technology from the University of Florida investigated the overarching research question: In what ways can a summer development experience around spoken conversational apps foster middle-school students' cognitive outcomes around computing and social-emotional outcomes of interest and identity formation related to STEM careers? The project also answered important research questions on how to engage middle-school students in learning AI and what type of learning outcomes are achievable.

Related Links: (https://campdialogs.org/)



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Through an inquiry process centered on developing conversational AI—spoken technologies that engage users in conversation—middle-school students investigated and created innovative computational applications. Young learners designed and implemented of a variety of personally relevant projects, including speech assistants, question-answering systems, and games. These projects can offer meaningful engagement that has the potential to transform the way middle-school students view computing and AI careers.

Pillar 2: Partnerships for Career and Workforce Preparation.
Researchers in computer science and educational technology from the University of Florida tested the hypothesis that students will display a significantly increased sense of identity and interest formation toward STEM careers following the 2-week summer development experience. The research team analyzed patterns of collaboration and participation to explain how the learning experience supports these outcomes.

Pillar 3: Strategies for Equity in STEM Education
This project engaged 210 historically marginalized middle-school students in Alachua County, Florida, in a summer program that taught them computer science and AI concepts. As it moves into its final year, the project will reach diverse middle school classes within urban and suburban schools in Alachua County, Florida.

Related ITEST Project:
Fostering Computer Science and AI Learning through Youth-Led Conversational App Development Experiences (Award# 2048480)

Principal Investigator(s):
Kristy Elizabeth Boyer (keboyer@ufl.edu)

Co-Principal Investigator(s):
Maya Israel

Project eSPAC3: Celebrating Latinidad to Develop Spatial Computational Thinking Skills

Project eSPAC3 (pronounced "eh-space") is a four-year National Science Foundation initiative aimed at developing upper-elementary students' spatial computational thinking skills and awareness of computationally-intensive careers, with a focus on celebrating Latinidad. It utilizes Minecraft: Education Edition to create an immersive, culturally affirming learning experience. Through family engagement, near-peer mentorship, and expert modeling via career videos featuring Latin@ professionals, it fosters a collaborative learning community that reinforces aspirational capital and elicits funds of knowledge. Project eSPAC3 prioritizes equity in STEM education by providing culturally relevant content and resources, ensuring students have exposure to culturally relevant rich experiences and opportunities to succeed.

Related Links: eSPAC3 Website (https://www.espac3.org/),eSPAC3 Career Workforce Videos (https://youtu.be/wreZfq_IvYg?si=62G6agUEnE9zBSHL),eSPAC3 Minecraft World Tour (https://youtu.be/6lUwDhE-SJ4)

Target Gradespan(s): Elementary school (K-5)
Project Category: Research Study , Youth-Based
Discipline(s): Computer and informational technology science , Engineering , Interdisciplinary , Mathematical sciences
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Project eSPAC3 innovatively utilizes Minecraft: Education Edition to foster spatial computational thinking and awareness of computationally-intensive careers among upper-elementary students, with a focus on celebrating Latinidad. Through culturally relevant experiences, family engagement, near-peer mentorship, and expert modeling via career videos, it creates an immersive, collaborative, and empowering learning environment.

Pillar 2: Partnerships for Career and Workforce Preparation.
Project eSPAC3 partners with Latin@ professionals to create career videos, showcasing real-world applications of spatial computational thinking. Additionally, eSPAC3 works with San Diego Workforce Partnership to provide resources and connections with professionals, enhancing workforce preparation.

Pillar 3: Strategies for Equity in STEM Education
Project eSPAC3 promotes equity in STEAM education through culturally relevant content, family engagement workshops, and near-peer mentorship. It emphasizes Latinidad, celebrates cultural wealth, and incorporates students' funds of knowledge.

Related ITEST Project:
A Culturally Relevant Approach to Spatial Computational Thinking Skills and Career Awareness through an Immersive Virtual Environment (Award# 2148732, 2148733)

Principal Investigator(s):
Wanli Xing, Perla Myers (wanli.xing@coe.ufl.edu)

Co-Principal Investigator(s):
Adan Escobedo Sanchez

Puffins!

Once hunted to local extinction, puffins have made a dramatic comeback and been re-established to historic nesting islands in Maine. This project combines a scientific adventure story about puffin restoration with data investigation on the relationships between puffin health and environmental factors. Students examine trends in several decades of curated National Audubon Society data about puffins, using an accessible open-source data tool to examine relationships among variables such as sea surface temperature and puffin weight. They also use data from puffin webcams and train an AI system to identify puffins. We are researching how to make these tools accessible to English language learners and how the technology enhances student engagement and understanding of what ecologists do. Students also learn about the careers of people from diverse backgrounds who have worked on Maine's puffin islands to learn how data are being used to study ornithology and climate change.

Related Links: NSF Award Abstract for Puffins (DRL-2241777) (https://www.nsf.gov/awardsearch/showAward?AWD_ID=2241777),Puffins summary and activity handout ITEST PI meeting May 2024 (https://docs.google.com/document/d/16Wq9YC0LHg_LaqINJZwE86EuL9Wzt2W3/edit)

Target Gradespan(s): Middle school (6-8)
Project Category: Exploring Theory and Design Principles (ETD)
Discipline(s): Data Science , Environmental sciences , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain)
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project uses CODAP (Common Online Data Analysis Platform) to engage students in examining data about the return of puffins and factors that affect their well-being. Relationships between variables are identified. Teachable Machine is used to differentiate puffin images from those of other birds and to identify puffin calls, using video/sound from puffin webcams. AI birdfeeders are used in students' schoolyards to provide experience with the affordances and challenges of AI.

Pillar 2: Partnerships for Career and Workforce Preparation.
The work is anchored in a scientific adventure story about ornithologist Stephen Kress, who brought puffins back to Maine over a 50-year period. Young interns working with puffins are featured in the book and in a card game "Guess My Puffineer," which uses photos and data about the careers of former interns. We use myriad data from the National Audubon Society concerning the work of seabird restoration experts.

Pillar 3: Strategies for Equity in STEM Education
The project takes place in Maine and works with new immigrant multilingual students from cities and low-income students from rural areas. We scaffold reading and writing for a range of students, using strategies designed and tested by partner teachers. We emphasize multiple and active learning strategies (e.g., growling like a puffin, designing a burrow) to engage a range of learners. The "Guess My Puffineer" game showcases careers of people of color and those from diverse backgrounds.

Related ITEST Project:
Puffins: Exploring how narrative, data science, and artificial intelligence enhance the study of ecology in middle school (Award# 2241777)

Principal Investigator(s):
Janice Mokros (Jan@tumblehomelearning.com)

Co-Principal Investigator(s):
Penny Noyce, Don Lyons

Robotic Enhanced Restorative Justice Gardening

Our work engages high school youth in Massachusetts and Louisiana in transdisciplinary learning of computational science, artificial intelligence, engineering, and restorative ecologies through the installation of automated urban gardening robots that we are calling restorative gardens. These gardens offer an opportunity to bridge traditional gardening and 21st-century technological skills while fostering community engagement by supporting youth in using emerging technologies to address critical issues such as food security. Drawing upon an emancipatory community design and research approach, our work involves youth in participatory action research in which they use research methods to make sense of and address social problems of community food insecurity by building and programming restorative gardens in their local communities. We focus our recruitment on youth who have been historically excluded from STEM fields and youth who do not have a particular interest in STEM. As such, a key aspect of our work is the longitudinal research of student identity and interest development. This is similar to our prior work where we have been tracking the impact of participation in our programs over two to three years.

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Interdisciplinary
Geographic Location(s): Rural , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
In partnership with the company Farmbot we are utilizing an AI enhanced, modularized gardening robot, the farm.bot. The farm.bot is an open sourced, computer numerical control (CNC), automated farming robot that has an easy-to-program API interface that allows the programming of the camera to engage the machine in automatic weeding, watering, and monitoring environmental conditions such as soil moisture, air temperature, and relative humidity.

Pillar 2: Partnerships for Career and Workforce Preparation.
We draw upon Boston College's Tools for Tomorrow curriculum which fosters career- and self-exploration, including identifying goals, resources, and barriers to careers and fostering flexibility to navigate barriers and adapt to change as needed in a rapidly changing work context. Youth examine how STEM skills are central in the attainment of rewarding and meaningful potential STEM and non-STEM careers, as well as in meeting the goals of helping their communities

Pillar 3: Strategies for Equity in STEM Education
Drawing upon an emancipatory community design and research approach, our work involves youth in participatory action research in which young people use research methods to make sense of and address social problems of community food insecurity by building and programming restorative gardens in their local communities. The restorative gardens offer multiple entry points and pathways for motivating and engaging youth who have different interests and are from different backgrounds and experiences in STEM.

Related ITEST Project:
Empowering Youth in STEM and Technological Careers through AI-Enhanced Sustainable and Community-Focused Urban Gardening (Award# 2241766)

Principal Investigator(s):
Mike Barnett (barnetge@bc.edu)

Co-Principal Investigator(s):
Avneet Hira, Helen Zhang

Semiconductors Curriculum and Learning Framework for High-Schoolers Using Artificial Intelligence, Game Modules, and Hands-on Experiences

Semiconductors are essential components of electronic devices, enabling advances in all important applications and systems such as communication, healthcare, and national security. In order to sustain the U.S.'s global competitiveness in the semiconductor industry, there is a growing demand for skilled semiconductor workforce. High schoolers are among the most frequent users of electronic devices. However, many do not know how these devices are designed and manufactured. To address the knowledge gaps and workforce needs in an equitable manner, this project will develop a semiconductor curriculum with the high-school-aged students, and with partners in higher-education, K-12, and industries, enhanced with AI and innovative technologies. Game-based semiconductor modules will be created for the students to play and learn with peers choosing culturally diverse avatars. These learning modules will be made available to a wide range of students through the project collaborator Stemuli, a game-based learning company. In addition, approximately 50 students each summer (years 2-4) will be engaged in in-person workshops hosted in Maine and Texas. Through these workshops, students will be engaged in hands-on activities and field trips to semiconductor companies such as Texas Instruments where they will connect their game-based learning with industry experiences. Based on students' feedback, the workshop and game curriculum will be designed and improved iteratively.

The project aims to help high-school students develop skills and career interests in the semiconductor fields through an innovative game-based learning platform, hands-on activities, and industry field trips. The overarching research question is: To what extent do the designs and integration of AI Educator (a generative AI tool for education), game-based learning, and hands-on experiences provide equitable access and strengthen students' engagements, awareness, interests, and knowledge in STEM careers? The AI Educator will provide students with suggestions, assistance, and additional insights about the subject. The AI component will tune the output content based on the student's interests and preferences to make the experience more relatable. Data collection will include students' attitudes, game activities, and hands-on learning outcomes. Design-based research methods will be used incorporating the NASA Task Load Index, t-test, interviews, and surveys to understand students' learning and efficacy of the game and workshop curriculum. The Technology, Pedagogy, and Content Knowledge (TPACK) framework will be used and refined throughout the AI and game technology integration into the semiconductor curriculum and education pathways. The project will be designed with a focus on equity, accessibility, engagement, and collaboration, catering to students from diverse backgrounds

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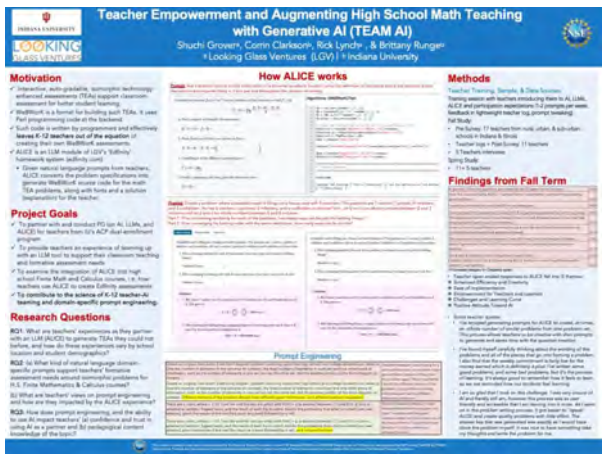
Related ITEST Project:
A Semiconductor Curriculum and Learning Framework for High-Schoolers Using Artificial Intelligence, Game Modules, and Hands-on Experiences (Award# 2342748, 2342747, 2342746)

Principal Investigator(s):
Lin Lipsmeyer, Prabuddha Chakraborty, Xiaoli Yang (LLipsmeyer@smu.edu)

Shaping Narratives for Teacher Empowerment and Augmenting Math Teaching with AI (TEAM AI)

TEAMAI is a collaboration between Indiana University (IU) Mathematics department and Looking Glass Ventures (LGV). In our research, we examine the high school teachers' use of ALICE, an AI LLM module of LGV's 'Edfinity' homework system (assessment platform at edfinity.com) in their Finite Mathematics and Calculus courses. Edfinity assessments utilize the, open-source WeBWorK format to deliver interactive, auto-gradable, isomorphic technology-enhanced assessments (TEAs) to support classroom assessment for better student learning. Given natural language prompts from teachers, ALICE generates the WeBWorK code for the corresponding interactive, isomorphic assessment along with hints and a teacher solution. Such code would otherwise have to be written by programmers and effectively left K-12 teachers out of the equation of creating WeBWorK assessments. Working with teachers in IU's Advance College Project dual-enrollment program from schools from rural, suburban, and urban Indiana, this project also studies what kind of natural language domain-specific prompts support math teachers' formative assessment needs and how prompt engineering, and the ability to use AI impact teachers' pedagogical content knowledge of the topic. We aim to contribute to the science of teacher-AI teaming, domain-specific prompt engineering, and shaping narratives of empowering and centering teachers in the artificial intelligence revolution.



Target Gradespan(s): High school (9-12)
Project Category: RAPID
Discipline(s): Mathematical sciences
Geographic Location(s): Rural , Suburban , Urban

Related Links: (https://www.nsf.gov/awardsearch/showAward?AWD_ID=2335835&HistoricalAwards=false), (https://www.nsf.gov/awardsearch/showAward?AWD_ID=2335834&HistoricalAwards=false)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The proposed work leverages AI to empower teachers with new capabilities for interactive assessment creation using natural language through partnering with LLM tools for code generation. The project uses ALICE, an LLM trained to generate code for complex math problems using natural language prompts.

Pillar 2: Partnerships for Career and Workforce Preparation.
The project is a partnership between Indiana University's Math department, mathematics teachers from high schools enrolled in IU's Advance College Project dual-enrollment program, and Looking Glass Ventures, an NSF SBIR-funded R&D organization that has developed edfinity.com, a math homework system, with tranformative AI features.

Pillar 3: Strategies for Equity in STEM Education
Teacher shortage is most sorely felt in high school math classrooms in rural and under-resourced urban school districts. By empowering teachers to team with AI to create formative assessments relevant to their classroom needs and students' contexts, they can better support the teaching and learning process in their classrooms.

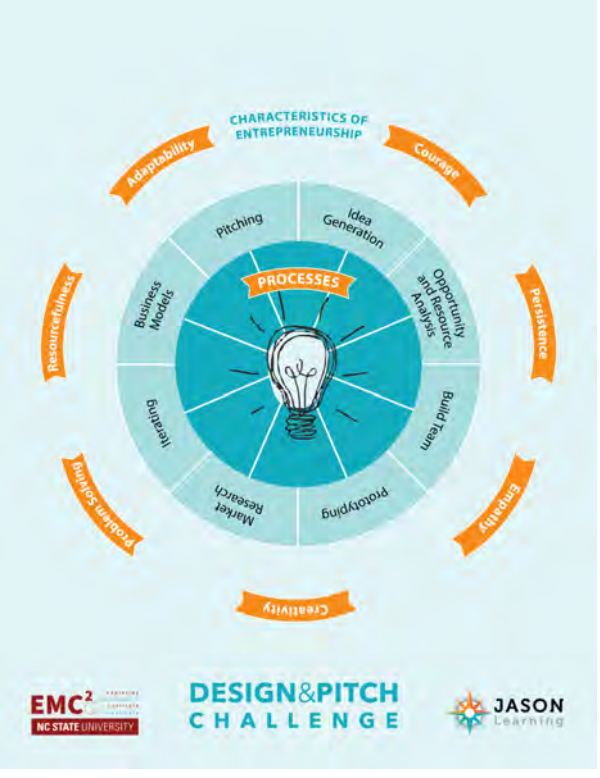
Related ITEST Project:
Empowering Math Teachers with an AI Tool for Auto-Generation of Technology-Enhanced Assessments (Award# 2335834, 2335835)

Principal Investigator(s):
Shuchi Grover, Corrin Clarkson (shuchi.grover@gmail.com)

Shark Tank for Math Learning

The D&P Challenges in STEM is a novel curricular form that combines features of project-based learning (PBL), design-based learning (DBL), and entrepreneurial-based learning (EBL) within entrepreneurial pitch competitions. Given the growing appeal of entrepreneurship and the often integral role of STEM in entrepreneurial innovation, situating STEM instruction within entrepreneurship could be an effective means for increasing students' interest and engagement in STEM, while also supporting rich STEM learning, especially in mathematics. The purpose of this research is to 1) adapt the middle grades-focused D&P curricular form for use in high school by designing nine new entrepreneurial challenges rich in high school STEM content; 2) examine the effects of these materials on high school students' STEM career interest and learning, especially with respect to mathematics; and 3) examine the impact of participation in an online professional learning network on teachers' implementation of the challenges.

Related Links: Design and Pitch Challenges in STEM (https://sites.ced.ncsu.edu/design-and-pitch/)



Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Mathematical sciences
Geographic Location(s): Rural , Suburban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
As students engage in Design & Pitch Challenges they utilize various technologies for the learning of rich mathematics content. These include, but are not limited to: spreadsheets, TinkerCad, Desmos, GeoGebra, and Datawrapper.

Pillar 2: Partnerships for Career and Workforce Preparation.
Entrepreneurship and the D&P Challenges in STEM offer a solution to STEM workforce development by exposing students to opportunities for using STEM to develop innovative solutions to socially, personally, and culturally relevant problems. Additionally, through identifying diverse challenge champions and entrepreneurial mentors, the D&P Challenges give students, especially those students who are from populations underrepresented in the STEM workforce, access to careers they may not have previously considered.

Pillar 3: Strategies for Equity in STEM Education
D&P is pioneering a new curricular form for high schoolers that leverages entrepreneurship to 1) increase students' engagement and learning in STEM, 2) integrate flexible and inclusive STEM career connections, and 3) broaden participation in STEM fields and careers, particularly for rural and female students and students of color.

Related ITEST Project:
Design and Pitch Challenges in STEM: Merging Entrepreneurship and Mathematics Learning (Award# 2048332)

Principal Investigator(s):
Erin Krupa (eekrupa@ncsu.edu)

Co-Principal Investigator(s):
Robin Anderson

Simulations for Learning Collaboration Skills and Developing Asset-based STEM Career Identities

The CASCADE collaborative research project is working with strategic partners and career partners to create interactive, narrative simulations for use in informal learning environments (ILEs) serving youth in grades 6-12, primarily African American and Latinx who would be first generation college students in their families. CASCADE modules promote learning of collaborative skills for addressing math tasks arising in STEM career fields, and developing STEM career identity. Each module focuses on STEM career fields that use math and includes a simulated environment and storyline to practice challenges in productive collaboration. CASCADE's three specific aims are to: 1) develop and refine modules that support math collaborative skills and STEM career identity, 2) develop program materials for the enactment of modules in ILEs, and 3) enact and study modules in ILEs to document evidence of impacts on youth's math collaborative skills and STEM career identity.

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI) , Research Study
Discipline(s): Data Science , Interdisciplinary

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Students work in virtual environments of STEM career fields with a narrative built around a math task arising in these careers. They collaborate with virtual partners in first-person perspective engaging with targeted challenges of collaboration. For each challenge, they choose among options reflecting varying levels of collaborative functioning, receiving feedback related to their choices that is both implicit (consequences in the story) and explicit (explanations about their choices and alternatives).

Pillar 2: Partnerships for Career and Workforce Preparation.
CASCADE involves simulations set in STEM careers for students to practice, with virtual partners, aspects of tasks, discourse, and social dynamics important to collaboration. To enhance student engagement and equity, the simulations provide feedback from STEM professionals about using math and collaboration in their careers, and guidance for navigating math-related careers. We partnered with 3 Black and 3 Latinx STEM professionals who shared feedback on collaboration when using math and guidance for career navigation.

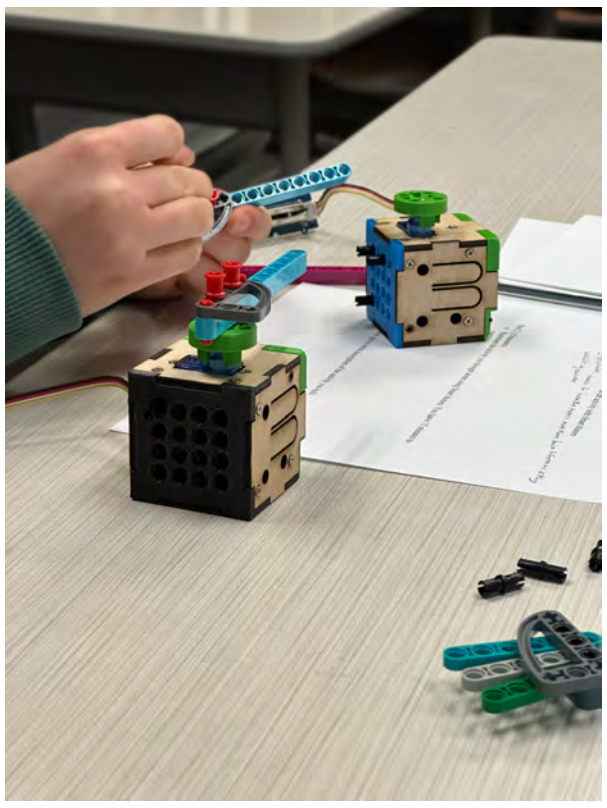
Pillar 3: Strategies for Equity in STEM Education
CASCADE's career-relevant feedback and guidance is grounded in the premise that communities possess diverse cultural wealth that offer assets to their members' adjustment and empower resistance to structural racism and oppression. As students progress through the CASCADE simulation modules, they hear personal narratives of Black and Latinx career mentors on themes of community cultural wealth to help them feel unity with others and reveal possibilities for STEM careers and strategies for career navigation.

Related ITEST Project:
Engaging Adolescents through Collaboration on Simulated STEM Career Scenarios and Mathematics Activities (Award# 2048985, 2048993)

Principal Investigator(s):
Daniel Heck, Jill Hamm (dheck@horizon-research.com)

Smart Motors - a low-cost platform for introducing supervised machine learning to children

Artificial intelligence and machine learning are quickly becoming critical tools for creativity and productivity. Through this RETTL project, we have developed a low-cost, AI-enabled hardware toolset called Smart Motors to introduce elementary school students to supervised machine learning concepts, which will prepare them to work confidently with AI in the future. This platform lowers students' barrier to entry for creating interactive mechanisms and incorporating motors and sensors through a training-first, rather than coding-first, approach. We have developed our tool and program over the past three years in collaboration with afterschool and summer program partners in urban North St. Louis, as well as with various outreach programs in rural New Hampshire and beyond. We are investigating three primary research questions: 1) How does introducing tangible artificial intelligence elements change upper elementary students' understanding of artificial intelligence concepts and attitudes towards artificial intelligence? 2) How do different levels of complexity and the variety of tangible artificial intelligence learning tools impact students' engagement and the diversity of their solutions and designs? and 3) What are the potential benefits and challenges of introducing tangible artificial intelligence elements in integrated engineering and literacy activities?



Related Links: Smart Motor Resource Page including Open Source Designs (https://smartmotors.notion.site)

Target Gradespan(s): Elementary school (K-5)
Project Category: Exploratory
Discipline(s): Engineering , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Interdisciplinary
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Innovative Use of Technologies in Learning and Teaching: Our project uses the newly developed Smart Motor hardware to introduce students to supervised machine learning concepts. These tools enhance literacy-integrated engineering design activities, where characters from grade-appropriate books are the clients. Simultaneously, students practice math skills such as collecting data and interpreting graphs.

Pillar 2: Partnerships for Career and Workforce Preparation.
Partnerships for Career and Workforce Preparation: Our pilot program was co-designed with educators from schools and outreach organizations in the North St. Louis community. Simultaneously, our team's AI experts are identifying skills and knowledge that will be crucial to the future of work in that field.

Pillar 3: Strategies for Equity in STEM Education
Strategies for Equity in STEM Education: Our project is co-designing our program with outreach partners and educators in North St. Louis to develop and pilot activities that are meaningful and engaging to the Black and African American students in those communities.

Related ITEST Project:
Integrating Artificial Intelligence with Smart Engineering and English Language Arts in Upper Elementary Education (Award# 2119174)

Principal Investigator(s):
Jennifer Cross (jennifer.cross@tufts.edu)

SRMPmachine: Preparing High School Students for Careers in Machine Learning through Mentored Scientific Research

SRMPmachine is a joint effort of the American Museum of Natural History and Massachusetts Institute of Technology designed to teach high school students machine learning (ML) through scientific inquiry. The project innovates within the Science Research Mentoring Program (SRMP) by creating a 175-hour “Summer Institute in ML,” followed by mentored-research experiences using ML. SRMPmachine focuses on ML, a key subset of AI that allows machines to learn patterns from data to make predictions or generate content. The Summer Institute has allowed 120 students to work with ML tools, evaluate models, and address bias by investigating problem sets informed by both natural science and larger societal issues. A subset of 30 students has spent over 130 hours during the academic year working on an ML-enabled research project. Preliminary results suggest that the Summer Institute increased students' knowledge of core ML concepts and interest in AI careers. This increase was sustained throughout the mentored research year among all students, whether or not they used ML in their research. Ongoing interviews are exploring students' attitudes toward AI, self-efficacy, persistence, and sense of belonging.

American Museum of Natural History

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Data Science , Emerging Tech (Artificial Intelligence, Quantum Computing, and Blockchain) , Interdisciplinary , Life sciences , Physics and astronomy
Geographic Location(s): Urban

Related Links: Visual reports with preliminary findings (https://drive.google.com/drive/folders/1ugyneXl6CXGts1xM44FX6QbUirkCUPRh?usp=sharing)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
During the Summer Institute, students conduct several mini scientific investigations while navigating the ML pipeline. Through plugged and unplugged techniques, students use four different ML methods: linear regression, principal component analysis, decision trees, and artificial neural networks. The culminating project involves using “Wallace,” a code-light professional platform used by biodiversity scientists, to run ML models to predict species distribution using locality data and climate variables.

Pillar 2: Partnerships for Career and Workforce Preparation.
SRMP is a STEM workforce development program that provides mentored-research experiences and scaffolded supports. SRMPmachine was co-developed by scientists, STEM educators, MIT AI experts, and SRMP alumni. Our alumni, all emerging computer science and IT professionals in academia and industry, were critical to the development of SRMPmachine. These young professionals captured both the spirit of what students need in their informal education experience and the skill sets that have propelled them in their early careers.

Pillar 3: Strategies for Equity in STEM Education
AI requires broad participation to fulfill its potential and minimize the risk of harm, which means creating learning spaces that support a diversity of learners as valued members of the AI community. We employed the YESTEM Core Equitable Practices (CEP) of “Authority Sharing” & “Shifting Narratives” to guide the development of the Summer Institute. These CEPs position educators and youth as "co-learners, co-disruptors, and co-creators of a more just world" within and through STEM (Greenberg & Calabrese Barton, 2021)

Related ITEST Project:
Preparing High School Students for Careers in Machine Learning through Mentored Scientific Research (Award# 2049022)

Principal Investigator(s):
Mark Weckel (mweckel@amnh.org)

Co-Principal Investigator(s):
Irene Lee

St. Elmo Brady STEM Academy

This project is an informal STEM intervention that combines partnerships between STEM and education faculty at the University of Houston with mentorship from the participants' families and STEM undergraduate mentors to provide hands-on STEM experiences to fourth and fifth-grade students of color. The project aims to increase awareness of and interest in STEM careers and broaden participation in STEM careers. Program components include hands-on activities that engage students with technology through the engineering design process that are led by undergraduate STEM mentors who also are from groups underrepresented in STEM careers; Scientist of Week, which exposes students either to a STEM pioneer from underrepresented groups or a STEM professional from an industry partner; the math problem of the day; and an end-of-year interactive STEM fair, during which students demonstrate their knowledge to larger audiences from their schools and communities. The research questions that guide this mixed-methods project include: 1) What strategies help conceptualize STEM knowledge in a manner that affirms students' racial identity and cultural ways of knowing? 2) How do students' STEM identity and awareness of and interest in STEM change over time? 3) How do families engage in their children's STEM learning in out-of-school STEM communities 4) What motivates STEM undergraduate students to become mentors, and what roles do they enact and why?

Target Gradespan(s): Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Chemistry , Engineering , Life sciences , Mathematical sciences , Physics and astronomy
Geographic Location(s): Urban

Related Links: Program Website (https://stelmobrady.egr.uh.edu/),Video Recap 2023-2023 (https://www.canva.com/design/DAGAuSRnP0k/6PHrsrO445I0_4ADlzYIug/watch)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Weekly, youth participate in hands-on engineering design activities that engage them with technology by building with the engineering design process as their framework. In addition to building innovative solutions to the weekly engineering design challenge, they also become ongoing users of standard tools used in STEM labs and industry (e.g., beakers, scales, lab notebooks). Recent activities have included windmill design, shoe design, and polymer exploration.

Pillar 2: Partnerships for Career and Workforce Preparation.
By partnering with local companies, we emphasize the possibilities of engineering careers. We include industry partners by (1) inviting them to volunteer during Saturday sessions, (2) inviting engineering professionals to serve as Scientist of the Week, and (3) highlighting the span of careers available at their companies (e.g., those that require certificates, two-year degrees, and bachelor's and advanced degrees). Participants get to interact with industry representatives and ask about their careers.

Pillar 3: Strategies for Equity in STEM Education
SEBA uses assets-based approaches and embeds equity throughout the program design. We are implemented in two of Houston's most diverse areas, thus connecting us to families who are historically underrepresented and underserved in STEM Education. Mentors are from similar backgrounds as participants. Mentors are paid to support them if they have to work to pay for school and trained in culturally responsive pedagogy to support the formation of strong relationships with participants.

Related ITEST Project:
Enhancing Underrepresented Student Engagement in STEM through Mentoring and Family Involvement (Award# 2148560, 2148561)

Principal Investigator(s):
Jerrod Henderson, James Holly Jr. (jahende6@central.uh.edu)

STEM Aspirations Among Refugee Families: A Comparative, Multiethnic, Qualitative Analysis

In this project, we examined how gender, race, and ethnic heritage shape the STEM and higher education aspirations of different communities of refugee youth and families participating in a university-community organization partnership. Families from various ethnic-based community organizations in Arizona–serving Bhutanese, Burundian, Congolese, Somali, and Syrian people–participated in this qualitative study. Using social cognitive career theory as our conceptual framework and a qualitative research design, we conducted interviews and focus groups with 27 families over two years to better understand their experiences. We found that the youth and families in our study experienced: (1) a recognition of the value of STEM education; (2) the value of consistent support from parents and community members; and (3) appreciation for the practical interventions provided by the university-community partnership. Additionally, families communicated conflicting perceptions of the salience of race and gender. Finally, we discuss the implications of these findings for teaching and learning in refugee/immigrant communities in the United States.

Findings: 1) Positive Perception of STEM Education 2) Parents' Support of Children's Choices 3) Beneficial Impact of University-ECBO Partnership 4) Conflicting Perceptions of Identity: Race, Gender, Ethnicity/Culture, and Religion

Implications: Our work has scholarly significance because it addresses the needs and trajectories of an understudied and marginalized group. Prior research suggests that refugee students may have specific psychological needs that continue to go unmet because of institutional resource and staff constraints (Jack et al. 2019). Our work suggests that students' broader community might serve to augment some of these psychological needs, so universities may consider building closer ties to ethnic and community-based organizations to facilitate STEM career accessibility. Moving forward, we recommend that college pipeline programs that work with immigrant students include families and community members (such as the ones described in this study) to ease the transition from secondary to higher education. This is especially important because the practical and cultural knowledge of immigrant people is often dismissed in collegiate settings. In other words, we advocate for higher education institutions to engage in large-scale partnerships with ECBOs. Cumulatively, institutional and systems level changes will undoubtedly lead to increased STEM aspirations and success for historically underrepresented populations.

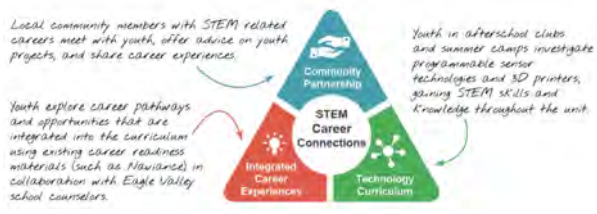
Related ITEST Project:
Promoting Aspirations in Science, Technology, Engineering, and Mathematics through Youth and Family Engagement
(Award# 2045306)

Principal Investigator(s):
Eugene Judson (Eugene.Judson@asu.edu)

Co-Principal Investigator(s):
Meseret Hailu, Nalini Chhetri, Shawn Jordan, Philip Klucsarits

STEM Career Connections

Our goal for the STEM Career Connections project is to develop an innovative career readiness model for both in and out of school settings that will profoundly increase the knowledge of, and interest in, STEM (science, technology, engineering, mathematics) and computing careers for middle school youth within Eagle County, Colorado, who are often underserved in STEM fields. To achieve this goal, we have three integral components of the project: • a community partnership working together to support youth engagement in STEM and computing career pathways • a STEM curriculum where youth use advanced technologies (such as 3D printers or programmable sensors) to engage in science and engineering investigations • integrated career experiences that encourage youth to make personally-relevant connections with local STEM and computing occupations. During this three-year research project, we will investigate the following questions: 1. What tools and practices enable a community partnership to support youth exploration of locally relevant STEM and computing pathways? 2. What learning experiences enable middle school youth to create personally relevant connections with STEM and computing careers? 3. To what extent does STEM Career Connections stimulate youth interest and learning in STEM and computing careers?



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Computer and informational technology science , Data Science
Geographic Location(s): Rural

Related Links: (https://www.colorado.edu/program/stempartnershiptoolkit/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
students use programmable sensors to engage in locally-relevant, data-enabled science and engineering investigations. Sensor technologies, and their resulting data streams, are a critical component of the big data and machine learning revolution transforming many industry sectors (Makridakis, 2017). Understanding how computers use sensors to perceive the world is one of the five big ideas in the AI4K12 standards (Touretzky et al., 2019) and is central to AI education [ITEST Pillar 1].

Pillar 2: Partnerships for Career and Workforce Preparation.
A key goal of the DTI work was to establish and nurture a community partnership consisting of a dozen individuals representing school district leaders and educators, informal education leaders, local business leaders, parents/caregivers, and students to provide critical coordination, adaptation, and recruiting functions. Importantly, through the partnership, local organizations identified and created complementary learning experiences that used sensor technologies, emphasizing the unique goals of their organizations.

Pillar 3: Strategies for Equity in STEM Education
The STEMCC model and curriculum integrates connections to STEM careers and includes STEM mentoring experiences for students. The STEM career activities involve researching STEM careers that utilize sensors and build on students' interests. Mentors provide first-hand exposure to local STEM careers and guidance to students during project design. Mentors participate in PL, where they learn to create meaningful interactions that are relational and collaborative, building on students' interests, and culturally responsive.

Related ITEST Project:
STEM Career Connections: A Model for Preparing Economically-Disadvantaged Rural Youth for the Future Workforce (Award# 1949299, 1949322, 1948709)

Principal Investigator(s):
Mimi Recker, Tamara Sumner, John Ristvey (mimi.recker@usu.edu)

Co-Principal Investigator(s):
Quentin Biddy

STEM Identity Work and Play through Place-based Learning and Digital Storytelling

As young people experience challenging climate events, they may feel powerless to shape the future and uncertain about STEM-based solutions. This project focuses on the potential of place-based learning, field science, and digital storytelling to nurture diverse middle school youths' environmental agency, STEM career knowledge, and STEM identities. The project includes out-of-school STEM learning to investigate the history, ecology, and restoration of a local watershed. The watershed has unique biodiversity and is increasingly impacted by negative climate events in a city experiencing rapid population growth. Youth create stories about the land, water, people, and history of the watershed using podcasts, augmented reality, and digital zines. Digital storytelling allows youth to recapture a sense of agency amidst climate anxiety as the stories' digital and mobile nature can reach diverse audiences and encourage multiple ways of knowing about a socioecological system. A primary contribution is a grounded theory of identity play, which involves youth exploring new roles and self-narratives that challenge societal expectations or current personal narratives. Identity play is nonlinear, not always predictable, and horizon-expanding. Identity play allows us to design for multiple STEM entry points and pathways, recognize the productivity of youths' decisions not to pursue certain pathways, and explain impacts of out-of-school STEM experiences on diverse youths' career choices.

Related Links: (https://news.vanderbilt.edu/2023/11/28/vanderbilt-researchers-explore-novel-science-education-approach-to-build-youths-agency-amidst-climate-anxiety/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Youths' digital storytelling in the form of podcasting, zines, and augmented reality emphasize youths' agency amidst growing climate anxiety. Equitable STEM education involves the dissolution of epistemological silos to create learning environments that leverage youths' ways of knowing in service of STEM learning. Too, there is growing recognition that techno-rational solutions to climate issues and other global health issues are incomplete. In this context, digital storytelling takes on new importance.

Pillar 2: Partnerships for Career and Workforce Preparation.
We start with the assumption that STEM people are not cut from the same cloth—they have different ways of thinking, being, and acting. We are developing a STEM profile instrument that illustrates the multiple ways to be a STEM person and engage in STEM, including: explorer, inquirer, naturalist, futurist, tech innovator, advocate, cultural investigator, and empath. The STEM professionals we invite to help with the project represent vastly different interests, professions, and talents.

Pillar 3: Strategies for Equity in STEM Education
Our approach emphasizes the importance of culturally relevant uses of technology, epistemic heterogeneity (multiple ways of knowing), and multimodal engagement. Digital stories are boundary objects, combining culturally relevant and horizon-expanding discourses and practices, and centering youths' voices. Our pedagogical framework includes connection, investigation, interrogation, imagination, and action. Further, the STEM profile categories are identity-affirming and horizon-expanding tools.

Related ITEST Project:
Place-based Learning, STEM Identity Work and Identity Play with Storytelling Technologies (Award# 2241814)

Principal Investigator(s):
Heidi Carlone (heidi.carlone@Vanderbilt.Edu)

STEM Storytelling with Podcasts: Engaging Blind and Low Vision and Sighted Students in STEM through Podcasts

The STEM Storytelling through Podcasts (SSP) project focuses on broadening participation for blind and low vision and sighted upper elementary students by engaging them with podcast technology to promote access to STEM and introduce students to STEM/ICT careers.

Related Links: SSP Project Summary (https://stem.oregonstate.edu/research-evaluation-portfolio/projects/stem-storytelling-with-podcasts-for-blind-visually-impaired),Tumble Podcast website (https://www.sciencepodcastforkids.com/),Independence Science website (https://independencescience.com/),Associated Universities, Inc. website (https://aui.edu/)

Target Gradespan(s): Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary

Pillar 1: Innovative Use of Technologies in Learning and Teaching
This project uses Tumble Media's science podcast as a model for integrating STEM podcasts and podcast technology in ways that are accessible for blind and low vision students.

Pillar 2: Partnerships for Career and Workforce Preparation.
Oregon State University research team, Tumble Media, and Independence Science have partnered to create podcasts and resources so teachers and students can gain skills in digital design, technology use, and science communication as essential tools in being a scientist. We theorize that by listening to and producing representative STEM podcasts through this project, blind and low vision and sighted students will increase their STEM career interest and appreciation that STEM careers are open to people with disabilities.

Pillar 3: Strategies for Equity in STEM Education
The SSP project will include a listening track and production track to engage blind and low vision and sighted elementary aged students (grades 3-5) in STEM storytelling through podcasts. The listening track will use podcasts in grades 3-5 classrooms to introduce STEM and ICT careers, featuring blind and low vision and sighted scientists while the production track will engage students in using podcast media to communicate about STEM & ICT careers featuring blind and low vision and sighted scientists.

Related ITEST Project:
Engaging Blind, Visually Impaired, and Sighted Students in STEM with Storytelling through Podcasts (Award# 2148711, 2148712)

Principal Investigator(s):
Sara Robberson Lentz, Kelly Riedinger (sara@tumblepodcast.com)

Stimulating GIS Careers through Geospatial Explorers

This project builds on the successful Geospatial Semester (GSS) high school course to explore how to infuse a powerful STEM tool into Career and Technical Education (CTE), computer science and social sciences courses in Chicago Public Schools (CPS) and schools in Puerto Rico. Our work builds on the core strengths of GSS by providing students with a robust introduction to GIS tools using ArcGIS Online, which is available for free to schools and the lessons are designed to be accessible for people new to GIS. Through design-based implementation research, we have customized the project supports to align to various content areas and the context of CPS and Puerto Rico. For CTE business, students have been conducting spatial market analyses to develop business plans that identify possible business locations that have high populations of their target demographic groups. For computer science, students are developing computational data analysis skills to investigate local issues, like food deserts. For AP US History, students are examining history from a spatial perspective, such as analyzing historical human migration patterns.

Related Links: Case Study of GIS Use in a Health Science Class (https://www.jointhepartnership.net/partnership-opportunities/#case-study)

Target Gradespan(s): High school (9-12)
Project Category: SPrEaD
Discipline(s): Computer and informational technology science , Data Science , Other
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
At the core of the GSS project is support for student spatial analyses using ArcGIS online, which is the most widely-used professional GIS tool. ESRI provides ArcGIS licenses for free to K12 students. The GSS project has co-designed lessons with teachers to provide structured scaffolding that helps students develop basic GIS skills and through those skills, students are able to investigate a variety of personally-relevant topics. We are also exploring the use of an AI chatbot that can guide students' use of ArcGIS.

Pillar 2: Partnerships for Career and Workforce Preparation.
GIS is one of the fastest growing segments within the IT field. Students have the opportunity to develop their spatial reasoning abilities, a key skill for STEM career success. The GSS project has developed career profiles of 8 GIS professionals in Chicago, published through Futurum. Teachers have incorporated this guide into their GIS lessons to give students a vision of careers in GIS. Our research has shown that students' who were exposed to GIS through the career guides had higher expectancies of success in GIS.

Pillar 3: Strategies for Equity in STEM Education
Through iterative co-design between teachers and researchers, 92% of the GIS-infused lessons were judged to be culturally responsive. Our work serves diverse CPS students—in our most recent GIS-infused unit, 33% of students identified as black and 23% identified as Latinx. Students' perceptions of equity in their GIS-infused classes predicted expectancy of success in computer science (CS) and interest in taking more CS courses. In addition, 100% of the students in Puerto Rico identify as Hispanic.

Related ITEST Project:
Adapting and Implementing a Geospatial High School Course in Career and Technical Education Clusters in Urban Settings (Award# 1759371, 1759370, 1759360)

Principal Investigator(s):
Steven McGee, Robert Kolvoord, David Uttal (mcgee@lponline.net)

Supporting African American Young Women in Creating Signature Making Artifacts

The AAMASE project develops and researches a model for engaging high-school-aged African American women from low-income families in STEM-related making and entrepreneurship educational programming in a makerspace. Participants explore multiple Making disciplines (e.g., ceramics, textiles, resin, woodworking and metalworking) and entrepreneurship. New pathways to STEM careers open for these young women as they make connections among their strengths and interests, and the knowledge and skills they develop. Participants spend about 3 hours a week over 8 weeks in the program, culminating in an in-depth project that takes 6 to 10 hours to build. Mentors from the makerspace support participants to develop their project designs and relevant skills. The aim is for each participant to move towards creating a signature making artifact, a creative work with personal and cultural significance to the maker (Barton, Tan, and Rivet, 2008). The project uses an iterative, participatory design research framework to bring the participants together with makerspace experts, facilitators and researchers to co-create processes and products that reflect the young women's interests. The project's research investigates participants' development and interests and how the makerspace community is impacted. The research uses qualitative and quantitative methods including artifact elicitation, focus groups, interviews, and ethnographic field observations to iteratively develop the program model.

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI) , Youth-Based
Discipline(s): Interdisciplinary
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The AAMASE program brings African-American young women into a community makerspace to explore multiple making disciplines, including metalworking, woodworking, textiles, resin, 3D printing and ceramics. The project aims to work with the participants to develop making and entrepreneurship activities that appeal to them.

Pillar 2: Partnerships for Career and Workforce Preparation.
New pathways to STEM careers open for these young women as they work with making discipline experts to connect their interests to projects that they design, prototype, and build.

Pillar 3: Strategies for Equity in STEM Education
The AAMASE project aims to center the experience of young African-American women as developing makers. An iterative, participatory design research framework brings participants together with makerspace experts, facilitators and researchers to co-create processes and making activities that reflect the young women's strengths and interests. The project aims to explore strategies for making makerspaces (and associated STEM-related activities) more welcoming to populations that better reflect their local communities.

Related ITEST Project:
Engaging African American Young Women in STEM and Entrepreneurship Through Community-Centered Making (Award# 2148543)

Principal Investigator(s):
Ken Rafanan (ken_rafanan@terc.edu)

Supporting Rightful Presence in Museum Spaces: Youth as Participatory Designers of Indigenous Mixed Reality Science Exhibits

This project addresses the ongoing marginalization of Indigenous communities in informal science learning spaces by developing and studying a model that strengthens rightful presence, a justice-centered framework that promotes a greater sense of belonging and shift in institutional power. Ohlone youth and families engage in participatory co-design to create immersive Indigenous science exhibits using mixed reality technologies that will be installed at the Lawrence Hall of Science, UC Berkeley's public science center. The research employs participatory design-based methodologies to investigate outcomes of youth participation in the design of mixed reality exhibits; the development of a participatory design model that centers Indigenous Science; and ways to support informal science educators to center Indigenous Science. The research seeks to understand how youth develop a sense of belonging, science identity, and interest in STEM careers through their participation and how these aspects amplify their rightful presence in science spaces. The research is guided by an Ohlone Research Advisory Committee and will analyze data from interviews, focus groups, observations, and design products. The tappenekšekma: Ohlone Science Diplomats program involves Ohlone youth and adult family members, who have met for a kickoff event and three design workshops thus far in year 1. An early insight is the importance of a family-based learning environment that centers Ohlone knowledge and values.

tappenekšekma
Ohlone Science Diplomats Program

Target Gradespan(s): Other
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary
Geographic Location(s): Urban

Related Links: Press release (https://lawrencehallofscience.org/news/the-lawrence-to-co-develop-mixed-reality-exhibits-with-ohlone-youth/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project features mixed reality (MR) technology which combines physical and virtual elements, enabling interaction with real-world and virtual objects. It can reveal hidden histories and alternative narratives, making it a unique platform for sharing cultural heritage, especially Indigenous knowledge. Therefore MR also offers opportunities for Ohlone youth to build STEM knowledge grounded in their cultural identity, supporting their rightful presence.

Pillar 2: Partnerships for Career and Workforce Preparation.
A collaboration between The Lawrence Hall of Science, UC Berkeley's School of Information, and mak-'amham/Cafe Ohlone, an Ohlone cultural organization, this work is part of a UC Berkeley effort called the 'ottoy initiative, led by Vincent Medina and Louis Trevino, co-founders of mak-'amham/Cafe Ohlone, which aims to foster understanding of and respect for Ohlone people and culture and to repair and improve the university's relationship with the Ohlone community. The project is driven by the Ohlone community.

Pillar 3: Strategies for Equity in STEM Education
By centering Indigenous perspectives in STEM learning experiences and highlighting connections between Indigenous cultural identities and contemporary STEM career pathways, the project aims to reframe STEM learning to increase Indigenous youth's rightful presence in STEM learning spaces, with the potential to lead to a more diverse STEM workforce. The program name "tappenekšekma" means both teacher and learner, reflective of youths' role as designers which positions them as skilled and knowledgeable learners.

Related ITEST Project:
Supporting Rightful Presence in Museum Spaces: Youth as Participatory Designers of Indigenous Mixed Reality Science Exhibits (Award# 2241805)

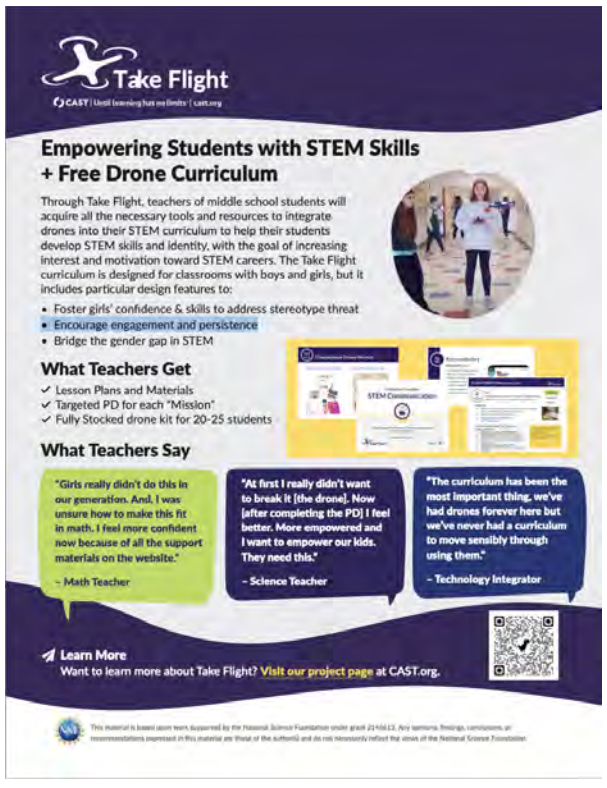
Principal Investigator(s):
Ari Krakowski (akrakowski@berkeley.edu)

Co-Principal Investigator(s):
Sarah Olsen, Jedda Foreman, Kimiko Ryokai, Vincent Medina

Take Flight: Rural Girls, Drones, and STEM Careers

This project uses drones in middle school science and career and technical education classrooms as a mechanism to increase female students awareness of STEM occupations, knowledge and skills in multiple STEM disciplines, and motivation to pursue STEM careers. This project confronts society's messaging and students' own perceptions of who can be, should be, and is good at STEM, which is often reinforced by the notion of there being a single path into STEM. The project will encourage female students from rural areas to develop their own STEM career goals by establishing a clear link between communal goals (those that are collaborative or altruistic) and success in STEM.

Related Links: Take Flight Project Page (https://www.cast.org/our-work/projects/take-flight-drones-rural-middle-school-girls-stem-careers),Video: Local NH News Featuring Students and Teachers Engaged with Take Flight (https://youtu.be/uPRpeRbdYT0?si=hIK8tgtMIQ2_6Rmg),Article: Local MT Newspaper Article on the use of Take Flight in a Local Classroom (https://leaderadvertiser.com/news/2024/mar/28/drone-curriculum-takes-flight-in-polson-middle-school/)



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary
Geographic Location(s): Rural

Pillar 1: Innovative Use of Technologies in Learning and Teaching
In Take Flight drones serve as the vehicle for larger conversations about the role of technology and the skills that are needed to be successful in STEM careers. Students learn to map airspace, use aviation specific vocabulary and build an understanding of STEM careers. And the curriculum also reinforces the collaborative nature of STEM and the need for varied perspectives to solve complex technology-driven problems. In Take Flight students learn to fly and code drones on cooperative teams.

Pillar 2: Partnerships for Career and Workforce Preparation.
Take Flight has partnered with middle school Career and Technical Education teachers and has been designed to be sustainable by Perkins funding, serving as a mechanism for promoting STEM-CTE courses. Take Flight includes Drone Career videos that highlight the varied STEM careers that use drones - from FAA air traffic controllers, to biologists studying endangered plants, the curriculum includes multiple activities and challenges designed to foster the development of STEM career thinking.

Pillar 3: Strategies for Equity in STEM Education
Take Flight leverages Universal Design for Learning Principles by providing materials in flexible formats, offering flexible tasks relevant to contexts with varied technology access, and rural educators and students as co-designs to remove access and implementation barriers. The curriculum highlights female role models working in STEM careers that use drones and the professional development includes research-based teacher "moves" that have proven effective for building motivation for STEM for middle school girls.

Related ITEST Project:
Using drone technology, communal motivation, and strength-based approaches to engage middle school female students from rural areas in STEM (Award# 2146613)

Principal Investigator(s):
Amanda Bastoni (abastoni@cast.org)

Co-Principal Investigator(s):
Jess Gropen

The Climate Action Simulation and 10,000 Pounds Project: A Team Based, Interactive Curriculum With Near-Peer Mentoring to Drive Students' STEM/ ICT Career Interests

This project fosters STEM/ICT career knowledge through team-based, Integrated STEM learning experiences where high school students in urban and rural schools create climate solutions at global and local scales, supported by near-peer mentoring. After exploring sources and solutions to climate change, student teams play a “Climate Action Simulation” game, using a technology-rich digital platform and guides for a set of social roles. The game’s “engine” is an interactive global model, called “Energy Resource and Decision Support” or En-ROADS, showing how changes in energy, economic, and public policy systems affect emissions and climate outcomes. In the “10,000 Pounds Project,” student teams develop emissions-reducing projects to benefit their school or community. A near-peer mentor facilitates the experiences while being a relatable role model and champion, encouraging STEM/ ICT identity. Through the effort of three community-based non-profits working at the intersection of climate and equity and a statewide energy workforce initiative, the project aims to increase the interest in and access to STEM/ ICT career paths for underserved students and youth. Minnesota has a growing demand for the STEM-literate workforce needed for clean energy and sustainability-related STEM/ICT jobs. To help meet that demand, a new webpage tells motivating energy and green job stories and showcases training opportunities and career pathways.

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Environmental sciences
Geographic Location(s): Suburban

Related Links: The Climate Action Simulation (https://www.climateinteractive.org/climate-action-simulation/),Climate Action Simulations at the University of Minnesota (https://environment.umn.edu/education/susteducation/climate-action-simulations-en-roads-our-experience/),10,000 Pounds Project (https://www.uml.edu/news/stories/2024/climate-mitigation-challenge-2024.aspx),Clean Energy Resource Teams - Careers (https://www.cleanenergyresourceteams.org/careers)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Combining a scientifically rigorous computer model with an engaging, richly social roleplay, the project offers a promising approach for aligning analytic, social and affective learning pathways. It combines simulation of the energy-climate system with simulation of the social aspects of group decision-making through roleplay. Playing the roles across industry, government, and activism, students are empowered to make decisions and to influence others’ decisions. Their collective aim, over rounds of negotiation, is to cr

Pillar 2: Partnerships for Career and Workforce Preparation.
Prior research shows that using the En-ROADS model and simulation is positively associated with changes in students’ climate science knowledge, affective engagement, and desire to learn more, thus enhancing STEM career readiness and interests in students, including those underrepresented in STEM fields. With the 10,000 Pound Project, students use STEM and teamwork skills to design an authentic (serving a real purpose) project that benefits their community. We know that such learning aligns well with the higher-level thi

Pillar 3: Strategies for Equity in STEM Education
Research shows that high impact educational practices, such as the simulations and project-based learning in this project, attract, engage and retain underserved students. Also, when instructional content is personally relevant and provides meaningful experience, learning outcomes are enhanced. With climate change and justice front of mind for many students, particularly those underrepresented in STEM fields and for whom climate disparities may be personally relevant, the focus of this project aims to open green job pa

Related ITEST Project:
Employing Peer Mentoring to Empower Youth to Become 21st Century Energy Leaders (Award# 2147839)

Principal Investigator(s):
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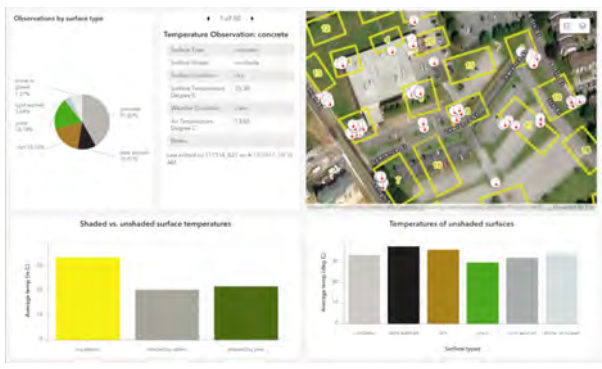
Co-Principal Investigator(s):
Beth Mercer-Taylor, Juliette Rooney-Varga

The SESI Collaborative: A multi-state, multi-site project integrating GIS into high school instruction



Three universities (Lehigh, Texas Christian, and Washington State University Tri-Cities) are collaborating with teachers at nine high schools to integrate GIS into core curricular content areas (Environmental Science, Biology, Chemistry, Physics, Geography, and more; including special education settings) and specialized classes (Robotics, Forensics, and so on). Our work with teachers spans technical instruction (learning about GIS), curriculum development (co-designing materials for the classroom), and pedagogical modeling. All of the tools we are using with teachers are cloud-based, so our collaboration can take place through a mix of online, face-to-face, and in-class interactions. The curriculum design principles are centered around localized geospatial inquiry into socio-environmental science issues (for example: investigating the urban heat island effect both on school campus and in the local community). Teacher outcomes include enhancement of geospatial TPACK and the patterns of their learning and implementation. Student outcomes include geospatial thinking and reasoning, interest in STEM-related college and career paths. Our project started in the first wave of the pandemic, and we were successful in adapting our work to a purely online context. Our teacher development model has been effective across a variety of contexts, as each of the three universities has a different collection of strengths and is working with its own distinct group of teachers.

Target Gradespan(s): High school (9-12)
Project Category: Scaling, Expanding, and Iterating Innovations (SEI)
Discipline(s): Other
Geographic Location(s): Urban

Related Links: Showcase of sample classroom & teacher PD materials from the SESI project (https://showcase-sesi-expand.hub.arcgis.com/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
GIS is an innovative, interdisciplinary technology that spans many STEM fields, including both hard sciences and social sciences. The geospatial tools we use include ArcGIS Online, Field Maps and Survey123 for data collection, and Dashboards, StoryMaps, and Hub sites for sharing.

Pillar 2: Partnerships for Career and Workforce Preparation.
Geospatial tools are needed in both STEM research and application, not to mention a wide variety of business, government, and commercial settings. Students in our participating teachers' classrooms are using professional-grade GIS and related tools while learning their curriculum-specified content and exploring STEM- and geospatially-connected college and career paths.

Pillar 3: Strategies for Equity in STEM Education
Our project connects with students from many traditionally underrepresented groups and settings. At the school level, we have rural, urban, and alternative high schools; at the classroom level, we have both general ed and special education classes. Additionally, the geospatial tools we are using are currently free for K12 educational settings. We budgeted for mobile technologies at each school to allow students to participate in data collection regardless of whether or not they owned a smartphone.

Related ITEST Project:
Expanding Socio-Environmental Science Investigations with Geospatial Technologies in High Schools (Award# 1949388, 1949400, 1949393)

Principal Investigator(s):
Richard Alexander, Thomas Hammond, Judith Morrison (curby.alexander@tcu.edu)

Co-Principal Investigator(s):
Kate Popejoy

The Sky Belongs to Everyone

The Youth Astronomy Network (YouthAstroNet for short) is a national, online community of youth, educators, and scientists that aims to help youth gain confidence and identity as someone who can do science through personal participation in authentic inquiry, supported by unique access to the resources of the Center for Astrophysics | Harvard & Smithsonian. Young people in every neighborhood, urban or rural, have questions about the universe. But many youth, particularly those in underserved communities, have few opportunities to engage their curiosity through rich, multidisciplinary, technology-enabled science learning experiences. YouthAstroNet helps middle school-aged students leverage their talents and creativity through astronomy programming as they build skills, and learn how these skills transfer to many exciting STEM disciplines. Our research has shown that science identity—the feeling of "being a science person"—is an important ingredient in motivating young people to persist in STEM learning. The Essential Elements of the YouthAstroNet experience—pursuing questions of personal interest with real telescopes; making sense of astronomical images through data analysis tools and hands-on activities; and youth-created capstone projects to communicate learning to peers, family and community—have been shown to produce gains in participants' science identity and STEM career interest. The project is now researching conditions that support sustainable scale up of the program..

Target Gradespan(s): Middle school (6-8)
Project Category: Scaling, Expanding, and Iterating Innovations (SEI)
Discipline(s): Physics and astronomy
Geographic Location(s): Rural , Suburban , Urban

Related Links: (https://youthastronet.sites.cfa.harvard.edu/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The project is scaling up a program & online learning platform for youth ages 11-14 that features customized access to robotic telescopes, support for learner-driven engagement with scientific and computational analysis tools and practices via image processing, and virtual interactions with digital STEM mentors

Pillar 2: Partnerships for Career and Workforce Preparation.
YouthAstroNet's digital mentors participate in live interactions and provide exposure to role models. Our strategy capitalizes on the benefits of both real time and asynchronous engagement opportunities, limiting the time burden on STEM professionals. Students in YouthAstroNet are exposed to a plurality of role models through the STEM "Role Model Profiles," in which diverse STEM professionals write about their experiences and pathway into science, as well as share anecdotes of moments of struggle in their work.

Pillar 3: Strategies for Equity in STEM Education
Three program principles leverage the cultural capital and everyday knowledge of students: 1)The sky belongs to everyone. The curiosity and creativity inspired by cosmic questions are universal experiences. 2)Listen to student ideas. Activities provide many opportunities to draw on students' own ideas, questions, and cultural identities. 3)There are many ways to be a science person. YouthAstroNet expands student ideas about science careers and how they can participate in science and still be fully the person they are!

Related ITEST Project:
YouthAstroNet: Research on the scale-up of innovative technology experiences in astronomy and science imaging (Award# 2049012)

Principal Investigator(s):
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Co-Principal Investigator(s):
Erika Wright

Transforming teaching mathematics with culturally relevant coding activties

The primary goal of our project is to improve achievement and interest in mathematics of New York City Black and Latinx students in grades 1-3 to build a foundation for interest and success in future STEM careers. We are working with two Title I schools in Brooklyn, NY, where we have 12 teachers-participants teaching in ICT (large percentage of students with disabilities) and bilingual (large percentage of English language learners) classrooms. In the first year of the project, the project team and the teachers co-designed a total of 146 culturally-relevant robot coding mathematics activities. This year the teachers are pilot-testing developed activities in their classrooms while participating in monthly grade-based PD workshops where they discuss the ways of introducing activities to the students and reflect on implemented activities. We also engaged STEM professionals of color to come to schools and share their stories with the students. In its design, this project seeks to build on key lessons from research: that integrating coding and robotics into math instruction in elementary school can help make math more engaging and relevant to the students; and that on-site, intensive professional development (and co-designed curricular activities) facilitate teacher learning, development of instructional repertoires aligned with culturally relevant pedagogy tenets, and take-up of mathematics reform activities.

Related Links: Birds and Bots of New York (https://www.birdsandbotsofny.org/)

Target Gradespan(s): Elementary school (K-5)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Mathematical sciences
Geographic Location(s): Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
In the classrooms, the teachers are developing an understanding of how to support students to problem solve through robot coding while engaging students in rich and mathematically meaningful activities that reflect key principles of culturally-relevant mathematics pedagogy. One example of this is in a lesson where students practice measurement and calculations of area in the context of serving as architects of a new playground. In doing measurements and drawings to test results with the Finch robot, students test their

Pillar 2: Partnerships for Career and Workforce Preparation.
Our project addresses STEM workforce development in two ways: 1) using robots in math exposes students to the simpler version of tools adults use in STEM careers - our partner, Vision Education & Media (VEM), a community-based STEM education organization, provided mentors that support teachers and students in the classrooms., and 2) culturally relevant pedagogy and guest lectures by STEM professionals of color helps students forming math identities in imagining future STEM careers.

Pillar 3: Strategies for Equity in STEM Education
Using culturally relevant mathematics coding activities will reveal cultural wealth of Black and Latinx students and improve their knowledge and attitudes toward math building foundation for interest and success in future STEM careers. The project led to development of teacher professional learning communities in two schools with large percentages of underserved students. These teachers will be affecting more and more students in diverse NYC neighborhoods beyond the length of the project.

Related ITEST Project:
Promoting learning and interest in mathematics for urban Black and Latinx children through culturally relevant daily robot coding activities (Award# 2147699)

Principal Investigator(s):
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Co-Principal Investigator(s):
Laura Hart

UNLV ITEST Project: Engaging Secondary Female Students in Ubiquitous Intelligence and Computing

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Exploratory
Discipline(s): Computer and informational technology science , Engineering
Geographic Location(s): Suburban , Urban

The major objectives of this Engaging Girls in Ubiquitous Intelligence and Computing (GUIC) project are to: 1) enhance secondary female students' academic self-concepts in computing and engineering fields through a constructivist learning environment; 2) enhance secondary female students' knowledge, skills, and interests in these fields; 3) increase the number of secondary female students' participating in STEM competitions; and 4) investigate the factors that influence female students' career choices in STEM and ICT fields. The major activities in each year include: 1) five-week GUIC Summer Camp to engage secondary female students in learning Arduino/C++ Programming and developing engineering projects, 2) one-week Spring Mentor Training Workshop to train teacher and UNLV student mentors, and 3) two-day Fall STEM Competition Workshop to promote STEM teachers to organize teams to participate in STEM competitions. From 2021 to 2023, we have engaged total 122 secondary female students from 53 CCSD middle & high schools (including 21 Title 1 schools) in GUIC Summer Camp. These students took three-week courses in Arduino & IoT and robotics designs then developed engineering projects in two weeks in a tiered team co-mentored by STEM teachers and UNLV engineering students. Through the Mentor Training Workshop, we have trained total 46 mentors (including 21 teacher mentors). The STEM Competition Workshop engaged total 22 STEM teachers. Total 27 STEM competition teams were supported.

Related Links: UNLV ITEST Website (https://nsil.sites.unlv.edu/ITEST.html),News article for 2023 GUIC Summer Camp (https://www.unlv.edu/news/article/coding-confidence-unlv-summer-camp-exposes-young-women-stem-careers),Telemundo News - GUIC Summer Camp (https://www.youtube.com/watch?v=N0CFlmqElHs&feature=youtu.be)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
During the GUIC Summer Camp, students will take courses in Arduino & IoT and robotic designs and develop engineering projects with emphasis on hands-on experience. Each student is provided with one Arduino training kit (consisting of Arduino Uno board & ESP32 board, sensors, breadboard, LEDs & resistors, and wires) so they can build and test the circuits. The engineering projects address different aspects of ubiquitous intelligence and computing fields targeting smart city and environmental applications.

Pillar 2: Partnerships for Career and Workforce Preparation.
We partnered with Clark County School District (CCSD) in recruiting secondary female students and teacher mentors. Several engineering projects were developed through partnership with one local startup company. During the summer camp, we invited two female faculty to give engineering seminars and took students to visit 3~4 research labs at UNLV. We also partnered with STEM competition organizers in publicizing opportunities and local professional society & industry in supporting STEM competition teams.

Pillar 3: Strategies for Equity in STEM Education
We sent out flyers to all CCSD middle and high schools and reached out to principals and teachers at Title 1 schools to recruit female students and mentors. Out of the 122 secondary female students, 44% of them were African American and Hispanic students. And 28.3% of the 46 mentors were from underrepresented minority group. Around 30% of the participants in sponsored STEM competition teams were female. Students were greatly inspired by the STEM journeys shared by female faculty, scientists, and their mentors.

Related ITEST Project:
Engaging Secondary Female Students in Ubiquitous Intelligence and Computing (Award# 1949585)

Principal Investigator(s):
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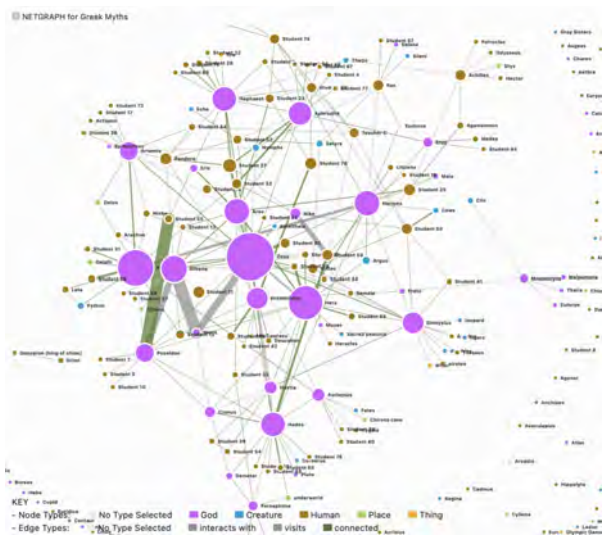
Visualizing Funds of Identity while Exploring Data Literacy Concepts

Integrating Students' Interests, Identities and Ways of Knowing with Network Visualization Tools to Explore Data Literacy Concepts is a Developing and Testing Innovations project responding to the growing recognition that data literacy is an increasingly important set of skills and network science in particular is at the heart of today's youth's experiences with technology. The goal of this project is to explore a synergistic approach in which middle school students (7th and 8th grades) use network visualization to learn about themselves and their communities, while simultaneously learning about the underlying network science and data literacy principles that make their exploration possible, and which are central to their experiences with many common technologies. To accomplish this, the project team has partnered with middle school teachers to design, implement, and study lessons about network visualization using the open-source Net.Create software tool. As part of a co-design process with teachers, we are creating history and English language arts lessons that will help students engage with core network visualization and data literacy practices in service of an exploration of their own, and their communities', interests and lives that also meets key digital literacy and disciplinary standards.



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Data Science , Other
Geographic Location(s): Rural

Related Links: VFOI and Net.Create Project Website (http://theraptlab.org/projects/netcreate)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
Our project utilizes the network visualization tool Net.Create (https://netcreate.org/) to provide opportunities for students to create data visualizations of subject-area content. These visualizations provide unique data representations through which students and teachers have the opportunity to engage with data literacy concepts and content knowledge while also exploring connections between themselves, the content, and their peers.

Pillar 2: Partnerships for Career and Workforce Preparation.
Through the novel opportunity to engage with Net.Create and data visualizations, our project introduces students to the ways in which network visualizations and networking are central to common technologies and integral to many career paths. Building on our partner district's existing computational thinking and STEAM pathways, this work provides students with deeper exploration of skills needed for careers and workforce opportunities related to data literacy and network visualizations.

Pillar 3: Strategies for Equity in STEM Education
Our project explores how network visualizations can heighten student engagement in learning by integrating student interests, content knowledge, and data literacy. Through the integration of student interests and identities, the lessons and visualizations are more responsive to students and they are able to see themselves reflected within the data literacy and subject-area content. Further, teachers learn about students' individual and collective identities and interests from what they share within the visualizations.

Related ITEST Project:
Integrating Students' Interests, Identities and Ways of Knowing with Network Visualization Tools to Explore Data Literacy Concepts (Award# 2241705, 2241706)

Principal Investigator(s):
Merijke Coenraad, Joshua Danish (mcoenraad@digitalpromise.org)

WATERS: Watershed Awareness using Technology and Environmental Research for Sustainability

The WATERS project addresses the need for water education and career readiness by developing and researching a universally accessible, student-centered curriculum that employs Universal Design for Learning (UDL) principles. This approach ensures that learning about water quality, usage, and stewardship is accessible to all students, enhancing their understanding of and engagement with vital water issues. Through hands-on activities, local data, and geospatial analysis, the curriculum aims to increase student interest in STEM careers by exploring watershed-related geographic, social, political, and environmental concepts. Conducted in diverse middle school science classrooms across CA, OR, PA, and VA, our research focuses on the impact of UDL integration on student learning, development of 21st-century skills, and interest in water-related careers. Notably, our findings show that students with disabilities who has access to UDL technologies achieved significantly higher content knowledge scores compared to their peers in the control group, underscoring the effectiveness of tailored educational supports in fostering equitable learning opportunities. Through WATERS, we are preparing a new generation to effectively steward our water resources and pursue STEM careers, ensuring a sustainable future for all.

Target Gradespan(s): Middle school (6-8)
Project Category: Scale-Up
Discipline(s): Environmental sciences

Related Links: WATERS (https://concord.org/our-work/research-projects/waters/)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The WATERS project leverages Universal Design for Learning (UDL) technologies to tailor educational experiences, ensuring accessibility for all students. By integrating UDL technologies, interactive tools and GIS modeling technologies into our curriculum, we enhance student engagement and understanding of complex watershed issues. This approach significantly boosts learning outcomes, particularly for students with disabilities, by adapting content delivery to diverse learning needs.

Pillar 2: Partnerships for Career and Workforce Preparation.
The WATERS project collaborates with local water agencies and environmental professionals via career videos to connect classroom learning with real-world water career opportunities. These partnerships provide students with practical insights into the water industry, enhancing their readiness for STEM careers. By bridging academic concepts with professional practices, we prepare students to meet the future demands of the workforce in water-related fields.

Pillar 3: Strategies for Equity in STEM Education
The WATERS project adopts a multifaceted approach to equity in STEM education by integrating UDL principles, ensuring that all students, including those with disabilities can access and engage with the curriculum. We focus on hands-on, inclusive activities that highlight diverse career paths in water-related fields, aiming to inspire a broader demographic of students to pursue STEM careers.

Related ITEST Project:
Watershed Awareness using Technology and Environmental Research for Sustainability (WATERS) (Award# 1850060, 1850051, 1849719)

Principal Investigator(s):
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Co-Principal Investigator(s):
Cindy Stunkard, Melinda Daniels, Diana Oviedo-Vargas

Welcome to the World Smarts STEM Challenge!

The World Smarts STEM Challenge is a virtual exchange that supports STEM (science, technology, engineering, and math) education in the United States and Ghana. Middle and high school students from Washington, DC, and senior secondary school students from across Ghana come together virtually to solve global issues in their communities with STEM solutions inspired by the UN Sustainable Development Goals.

Related Links: World Smarts STEM Challenge Video (https://www.youtube.com/watch?v=nS-u4GnYjlA),World Smarts STEM Challenge (Official Website) (https://www.irex.org/project/world-smarts-stem-challenge),Explore Students' Innovative Solutions | World Smarts STEM Expo (https://worldsmarts.vfairs.com/),World Smarts STEM Challenge (STELAR Profile) (entity:node/24274),World Smarts STEM Challenge (NSF ITEST PI Meeting 2022 Poster) (entity:node/24303)

Target Gradespan(s): Middle school (6-8) , High school (9-12)
Project Category: Developing and Testing Innovations (DTI) , Scale-Up , Youth-Based
Discipline(s): Chemistry , Computer and informational technology science , Data Science , Engineering , Environmental sciences , Geosciences , Interdisciplinary , Life sciences , Mathematical sciences , Physics and astronomy , Other
Geographic Location(s): Rural , Suburban , Urban

Pillar 1: Innovative Use of Technologies in Learning and Teaching
World Smarts provides students with an opportunity to utilize and engage with educational technologies that support communication, collaboration and simulate global workforce environments and scenarios. The official program tools include Canvas – Instructure, Pronto, Flipgrid, Zoom and Microsoft Teams. The program also offers and encourages students to use other school-approved tools for increased accessibility and usability considering each classroom setting and context. Educators are trained on how to use these tools.

Pillar 2: Partnerships for Career and Workforce Preparation.
The project engages school partners and STEM professionals to support students' engagement throughout the exchange. Partnerships with schools aid the facilitation of student supports, e.g. community services hours for career development. STEM professionals serve as mentors, guest speakers, and consultants to inspire students' STEM learning, provide technical advice, and offer insights on pursuing STEM/ICT careers. Students prepare and present at an expo where they practice public speaking to a diverse global audience.

Pillar 3: Strategies for Equity in STEM Education
A robust outreach plan and recruitment strategy engages educators and students from diverse and underrepresented backgrounds, including Black, Hispanic, economically disadvantaged and female students. Outreach to public schools includes showcasing diverse role models and collaborating with industry for real-world experiences. Educators engage in IREX-led training focused on implementation, inclusive facilitation methods, and fostering an environment that recognizes and respects diverse learning styles.

Related ITEST Project:
Exploring Key Predictors of STEM/ICT Career-related Outcomes Using the World Smarts STEM Challenge Model that Incorporates Global Engagement and Mentorship (Award# 2048417)

Principal Investigator(s):
Sarah Bever (sbever@irex.org)

You: Quantified

Target Gradespan(s): High school (9-12)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Interdisciplinary
Geographic Location(s): Urban

This project will promote data literacy in high school students by engaging them in learning about the Quantified Self, the practice of using technology to track and reflect on one's own biological, behavioral, physical, and/or emotional data. Learning activities will be designed to spark a broad interest in science and to help develop students? informed opinions about the role of human-generated data in public life. To achieve this goal, the project will develop and test software tools as well as lesson and professional development materials with which students and teachers can explore, analyze, and create novel, multimodal, and interactive representations of data, recorded by wearable biosensing devices. Students will (a) learn about how data from their bodies can be captured and interpreted through hands-on STEM activities that include the creation of interactive data representations; (b) design and execute small exploration projects to answer their own questions and create offline and online artifacts to communicate their findings; (c) engage in discussions that consider the privacy implications of using data-fueled services and applications and critically evaluate how their personal data is being used. During and after the project, instructors and students will have opportunities to connect with industry partners who work with biosensing and wearable technologies, and to access career and college readiness resources relevant to these and related data technology fields.

Pillar 1: Innovative Use of Technologies in Learning and Teaching
We will combine wearable biosensing devices, an online NGSS-aligned curriculum platform, and professional development materials to support students in exploring and representing data from their brains, bodies, and behavior. Using graphing and Brain/Body Computer Interface (BCI) technologies, students will develop creative multimodal representations to support interpretations of their data.

Pillar 2: Partnerships for Career and Workforce Preparation.
We will work with leading industry partners in mobile biosensing technology; with neuroscience student organizations who will support students' career and workforce preparation; and with digital arts organizations. Our tools will help students connect to these and other industry partners and to career and college readiness resources.

Pillar 3: Strategies for Equity in STEM Education
By offering a variety of data engagement avenues (data streaming from wearables, creative representation, remixing code, analysis, and graphs) and a guided inquiry approach, we will build on a range of students' STEM and non-STEM interests. We will further use a participatory design approach to develop learning materials and tools in a culturally responsive way; and we will work closely with students and educators associated with the Imagine NYC Schools initiative, which is dedicated to (re)imagining public schools in N

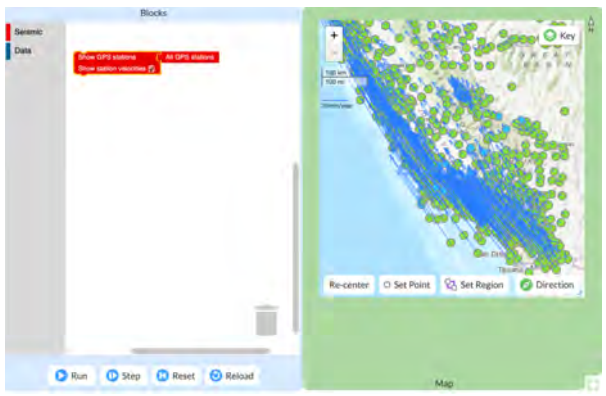
Related ITEST Project:
Promoting Students' Data Literacy through the Creation of Interactive Multimodal Representations of Biometric Data (Award# 2241751)

Principal Investigator(s):
Camillia Matuk (cmatuk@nyu.edu)

Co-Principal Investigator(s):
Suzanne Dikker

Youthquake

The goal of the Youthquake project is to engage middle school students in authentic computer-based investigations of earthquake hazards and risk in order to increase their interest in, and identity with, geoscience learning. YouthQuake's unique approach to the curriculum design process gathers a diverse team to co-design student learning experiences around investigating earthquake hazards and conducting risk assessments that are specifically related to the student's community. The curriculum will encourage geoscientific thinking and computational reasoning. The intention of the co-design process is to draw on each individual team member's expertise to build activities that engage students in learning and center that learning around community relevance. Together, the team will: (1) develop a series of activities that guide students in exploring local earthquake risk and community knowledge about mitigation options and preparedness; (2) engage students in authentic science and computer science-based investigations; (3) illuminate potential STEM careers by connecting students with scientists, graduate students, and other professionals related to earthquake hazards, risks and preparedness; (4)develop student understanding about natural hazards; and (5) develop students' computational reasoning as it relates to real-world geoscience investigations.



Target Gradespan(s): Middle school (6-8)
Project Category: Developing and Testing Innovations (DTI)
Discipline(s): Geosciences
Geographic Location(s): Urban

Related Links: Youthquake website. (https://concord.org/our-work/research-projects/youthquake/),The online youthquake curriculum module. (https://learn.concord.org/geo-youthquake)

Pillar 1: Innovative Use of Technologies in Learning and Teaching
The Youthquake project follows the computational practices of the geoscientists who conduct earthquake risk assessment, including (1) accessing and visualizing large datasets and (2) simulating and visualizing earthquake hazards and risk based on land deformation. Students leverage the power of computational models investigate problems framed around computational geoscience problems relevant to their neighborhoods. In this way, students' computational investigations are in service of solving problems for communities.

Pillar 2: Partnerships for Career and Workforce Preparation.
The youthquake partnership follows a collaborative theory of action in which the teachers, scientists, educational researchers, workforce specialist and curriculum designers work through a co-design process. The goal of process is to develop a curriculum that builds bridges between students' personal meaning and their perceived value of computational geology careers. Throughout the project, the partners will 1) negotiate multiple perspectives, 2) participate in the iterative curriculum design decisions, 3) learn from st

Pillar 3: Strategies for Equity in STEM Education
Strategy 1. Use contextual scaffolds that bridge real-world problems with students' diverse forms of science knowledge and experiences. Strategy 2. Engage students in authentic investigations and practices of career professionals. Strategy 3. Reflect cultural assets of student communities. Strategy 4. Provide opportunities for students to exercise epistemic agency in shaping their knowledge through computation-mediated science practices.

Related ITEST Project:
YouthQuake: Engaging urban students in a computational geology experience to forecast earthquake hazards and manage risks for their community (Award# 2241021)

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