California Education Learning Lab

REQUEST FOR PROPOSALS 2018-19:

"Improving Equity, Accessibility and Outcomes for STEM Gateway Courses"

Grant Awardees:

Proposal Name	Region(s)	Field(s)	Institutions
Full Grant Awardees			
Building and Testing a New Model for Continuous Improvement of High-Impact Online and Hybrid College Courses	Los Angeles	Statistics	UCLA, Cal State LA, Los Angeles Pierce College
Facilitating Student-Driven Learning through a Hybrid Interactive Learning Environment that Actively Listens to, Observes and Responds to Student Inputs and Behaviors	San Diego	Computer Science	CSU San Marcos & MiraCosta College
Eliminating Equity Gaps in Online STEM Gateway Courses through Humanized Instruction	Bay Area, Central Valley, North Coast, Orange County	Interdisciplinary	Foothill-De Anza Community College District, Modesto Junior College, Humboldt State University, UC Irvine
The Mechanics of Inclusion and Inclusivity in Mechanics	Central Coast	Engineering, Physics	Cal Poly-San Luis Obispo, Allan Hancock College, UC Santa Barbara
Developing Student Identity and Self-Perception as Capable STEM Thinkers and Learners at the Community College Level	Bay Area, North Coast	Chemistry, Math	College of Marin, UC Berkeley, Sonoma State University, Diablo Valley College
Community Sourced, Data-Driven Improvements to Open, Adaptive Courseware	Orange County, Bay Area	Chemistry, Math, Engineering	Santa Ana College, CSU Fullerton, UC Berkeley
Proof-of-Concept Grant Awardees			
Building College-Level Number Sense with Adaptive Technology	Inland Empire	Math	CSU San Bernardino & Riverside City College
Improving Retention in Engineering: Development of Unbiased Online Gaming Modules	Sacramento Metropolitan Area	Engineering	UC Davis, American River College, CSU Sacramento
California Challenges in STEM Energy Education	Central Valley	Chemistry, Math, Engineering	CSU Bakersfield, UC Merced, Bakersfield College

Building and Testing a New Model for Continuous Improvement of High-Impact Online and Hybrid College Courses

Region: Los Angeles
Institutions: UCLA, Cal State LA, Los Angeles Pierce College
Discipline: Statistics
Grant Amount: Up to $1,300,000

Principal Investigators: Jim Stigler (UCLA), Ji Son (Cal State LA), Edouard Tchertchian (Los Angeles Pierce College)

Co-Principal Investigators: Karen Givvin (UCLA) & Chris Hulleman (University of Virginia)

Abstract:
"Building and Testing a New Model for Continuous Improvement of High-Impact Online and Hybrid College Courses" will develop, implement, and continuously improve an online interactive textbook for introductory statistics. Statistics is critical not only for gaining entry into STEM careers, but also for excelling in them. Modern computational statistics is arguably more critical for future STEM careers than traditional mathematics courses. In addition, statistics may be the most direct pathway for students seeking to improve their mathematical preparation. This project's innovative design—based on learning science theories of how people develop deep understanding in complex spheres of knowledge—involves repeatedly engaging students with the deep conceptual structure of the subject area (in this case, statistical modeling), and includes a heavy emphasis on simulation, randomization, and other tools for both doing data analysis and understanding statistical ideas. The goal is not simply students' course completion, but the development of flexible and transferable knowledge—i.e., deep understanding—in all students.

"Building and Testing a New Model for Continuous Improvement" begins with an already completed Version 1.0 of a new interactive introductory statistics textbook, then works to improve the book and its implementation at scale. Through this work, the project team aims to create a replicable R&D model that engages researchers, designers/developers, and instructors in the work of scaling the innovation, and of continuous improvement of the book and its implementation. The team will implement a process of continuous improvement, so as to iteratively improve outcomes and reduce gaps among groups of students over time, making a bigger difference for students' success in the long run.

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Facilitating Student-Driven Learning through a Hybrid Interactive Learning Environment that Actively Listens to, Observes and Responds to Student Inputs and Behaviors

Region: San Diego **Institutions:** CSU San Marcos & MiraCosta College
Discipline: Computer Science
Grant Amount: Up to $1,038,000

Principal Investigator: Youwen Ouyang (CSU San Marcos)

Co-Principal Investigators: Nery Chapetón-Lamas (MCC) & Marisol Clark-Ibáñez (CSU San Marcos)

Abstract:
"Facilitating Student-Driven Learning through a Hybrid Interactive Learning Environment" addresses the high rates of students not passing introductory Computer Science (CS) classes. In this project, a collaborative and interdisciplinary team from California State University San Marcos and MiraCosta College will implement an iterative design and development education research process to create innovative hybrid offerings of the introductory CS sequence, recognized in California as C-ID COMP 122 and 132. In contrast to successful CS interventions in high schools, the college introductory CS curriculum typically focuses on how computers interpret instructions and relies on unduly difficult, abstract mathematical models. Pedagogically, the traditional lecture-heavy structure of college CS courses is in stark contrast to successful CS interventions in high school, lacking both real-world problems and the opportunities for students to use prior knowledge and background. They also do not utilize community-building pedagogy, which is a successful strategy to engage women and underrepresented minorities.

Partnering with Carnegie Mellon University (CMU) Silicon Valley, this project's interdisciplinary team will take a "bottom-up" approach to COMP 122 and 132 course re-design with feedback and focus groups from students and faculty. Using the CMU Open Learning Initiative (OLI) platform, the project will develop a comprehensive skill map for learning objectives in COMP 122 and 132, create culturally responsive learning resources and activities, and build a variety of student-focused and selectable modules that are adaptive to students' personal characteristics, background contexts, and learning experiences. In addition to online modules with learning goals assigned and assessed throughout the week, the newly developed courses will include weekly face-to-face lab activities that engage students in project-based learning and help students navigate and better understand the discipline of CS, thereby empowering students at the introductory level to gain a cognitive map of the field itself.

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Eliminating Equity Gaps in Online STEM Gateway Courses through Humanized Instruction

Regions:	Bay Area, Central Valley, North Coast, Orange County	**Institutions:**	Foothill-De Anza Community College District (FHDA), Modesto Junior College, Humboldt State University, UC Irvine
Disciplines:	Interdisciplinary		
Grant Amount:	Up to $1,300,000		

Co-Principal Investigators: Michelle Pacansky-Brock (FHDA), Sarah Williams (FHDA), Michael Smedshammer (Modesto JC), Brent Wedge (Modesto JC), Kim Vincent-Layton (Humboldt State), Jeffrey White (Humboldt State), Di Xu (UC Irvine)

Abstract:

Online STEM gateway courses hold significant potential to improve access to STEM education among nontraditional students and students from underrepresented groups in California. Currently, however, the performance gaps between online and face-to-face learning seem to be particularly large among underrepresented minority students. As a result, online learning, without fundamental improvement in instructional effectiveness and student supports, may exacerbate the STEM academic pathway leak for URM students. “Eliminating Equity Gaps in Online STEM Gateway Courses through Humanized Instruction” proposes a 3-year plan to initiate a systemic shift in the culture of online and hybrid STEM instruction across California public higher education institutions.

Guided by the psychological theories about distance learning and social presence, the project team will implement a large-scale, collaborative online professional development program, the Humanizing Academy, to address a crucial challenge to successful learning in an online environment: greater difficulties in enabling effective human interaction. Specifically, this proposal will test whether “Humanizing” a course—defined as efforts to help instructors to develop empathy, presence, and awareness, as well as pedagogies to improve instructor-student relationships and build classroom community—can help improve instructor-student and student-student interactions in online STEM courses, strengthen students’ sense of belonging and engagement, and increase learning outcomes in gateway online and hybrid STEM courses, particularly for URM students. Faculty, in partnership with instructional designers, will learn how to use free to low-cost digital tools and effectively apply them to the design and facilitation of their courses to foster instructor-student relationships.

The technology-enhanced pedagogical practices that are found to improve engagement and success for URM students will be scaled across the CCCs, CSUs, and UCs through the Humanizing Academy, which will be followed by a supportive course redesign period. Evidence-based practices will be shared publicly in the form of a “Humanizing Online STEM Courses” Practitioner Toolkit.

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The Mechanics of Inclusion and Inclusivity in Mechanics

Region: Central Coast

Disciplines: Engineering, Physics

Grant Amount: Up to $1,300,000

Institutions: Cal Poly-San Luis Obispo, Allan Hancock College, UC Santa Barbara

Principal Investigators: Brian Self (Cal Poly), Dominic Dal Bello (AHC), Danielle Harlow (UCSB)

Co-Principal Investigators: Robert Jorstad (AHC), Brian Youngblood (AHC), Andrew Maul (UCSB), Geraldine Cochran (Cal Poly), Benjamin Lutz (Cal Poly), Laura Ríos (Cal Poly), Peter Schwartz (Cal Poly), Stamatis Vokos (Cal Poly)

Abstract:

Mechanics—the study of motion and of the action of forces on bodies—is a core topic in both physics and engineering that is rife with nonintuitive concepts and content that many undergraduates find challenging to master. Scholars have grappled for decades with developing educational approaches to complex mechanics topics. Although mechanics includes core topics across both engineering and physics, many faculty do not form strong connections between disciplinary treatments of these common principles in ways that might enhance performance, identity, belonging, and ultimately persistence in STEM.

To address these issues, "The Mechanics of Inclusion and Inclusivity in Mechanics" establishes an interdisciplinary partnership across the California Community College, the California State University, and the University of California systems. This project seeks to eliminate equity and performance gaps in mechanics courses by (a) developing a suite of adaptive web-based tools that incorporate videos that illustrate why a topic is relevant to diverse professionals in the real world and adaptive tests, while (b) leveraging those cognitive tools and affective interventions to establish a sense of belonging, a strong STEM identity, and deep conceptual understanding. Parallel to these online efforts will be the implementation of evidence-based practices in the face-to-face classroom, such as the integration of Learning Assistants, implementation of hands-on, minds-on experiments, and development of a supportive, team-based learning environment, in which collaborative norms minimize microaggressions and toxic gendered interactions among team members.

To cultivate a sense of belonging and STEM identity, our work will target the development of coherent conceptual understanding as opposed to memorization (so that students feel that their own ideas contribute to the sense-making attempts of the group), situate problems within authentic scientific and engineering contexts (so that students see the relevance of what they learn to the needs of their communities), and highlight contributions by non-traditional scientists and engineers (so that students see themselves in them). The project will disseminate its resources, a framework for faculty development focused on both the instructional materials and the design of inclusive classrooms, and results of its research throughout the California educational system, online, as well as through professional conferences and publications.

California Education Learning Lab RFP 1 Awardees

Developing Student Identity and Self-Perception as Capable STEM Thinkers and Learners at the Community College Level

Regions: Bay Area, North Coast

Institutions: College of Marin, Sonoma State University, Diablo Valley College, UC Berkeley

Disciplines: Chemistry, Math

Grant Amount: Up to $1,300,000

Co-Principal Investigators: Paul Daubenmire (College of Marin), Hien Nguyen (College of Marin), Jennifer Lillig-Whiles (SSU), Carmen Works (SSU), Cory Antonakos (DVC), Erin Palmer (DVC), L. Ellen Beaulieu (DVC), Angelica M. Stacy (UC Berkeley)

Abstract:

Pervasive narratives about scientific brilliance exclude many students from pursuing careers in science. These narratives suggest that what counts is innate talent, knowing lots of information, and being quick and correct. The traditional design of STEM courses perpetuates these narrow views, which disproportionately impact students historically underrepresented in STEM.

The goal of "Developing Students' Identity and Self-Perception as Capable STEM Thinkers and Learners" is to disrupt these narratives and misplaced assessments of what defines scientific brilliance. This project designs materials to help both instructors and students to see science as an expansive and inclusive set of practices. It explicitly defines scientific competence as participation in these practices. The diverse project team will use the results of research in the learning sciences and their collective expertise to:

1) Develop group-worthy equitable in-class activities and complementary social supports to empower students to recognize and develop their talents by practicing science; and
2) Empower faculty to build an inclusive classroom climate.

The activities for students center on providing data and information that foster thinking like a scientist by looking for patterns, generating rules, asking questions, and being open to ideas from team mates. The workshops and faculty engagement components offer supports for building a classroom environment that values the assets all students bring and that builds student talent. The materials produced will be online transferable modules that will be accessible to faculty across California.

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Community Sourced, Data-Driven Improvements to Open, Adaptive Courseware

Region: Orange County **Institutions:** Santa Ana College, CSU Fullerton, UC Berkeley

Disciplines: Chemistry, Math, Engineering

Grant Amount: Up to $1,300,000

Co-Principal Investigators: Crystal Jenkins (Santa Ana College), Nina Robson (CSU Fullerton), Zachary Pardos (UC Berkeley), Lauren Herckis (Carnegie Mellon University)

Abstract:

"Community Sourced, Data-Driven Improvements to Open, Adaptive Courseware" will improve outcomes for STEM learners in targeted courses by deploying and improving open, adaptive courseware. This project builds on Open Learning Initiative (OLI) and Lumen Learning courseware that has been demonstrably effective in closing gaps and improving performance for underrepresented learners in STEM.

The project has two main thrusts: effectiveness and barriers. Effectiveness research will investigate the impact of multi-sourced data driven improvement on outcomes for targeted STEM learners, and barriers research will investigate the impact of this approach on faculty attitudes and culture. Improvements will be guided by analytic tools developed for this project that provide faculty, student, and crowdsourced feedback and participation. This approach ensures that student voices will play a central role in identifying areas of difficulty, evaluating materials and improvements, and recognizing student experience. Barriers research expands upon established protocols from Carnegie Mellon University, including embedding a cultural anthropologist who will use a mixed-methods approach to better understand barriers and facilitators for effective adoption of technology enhanced learning (TEL) innovations. This research complements and informs effectiveness research, employing a research-based approach to integrate these new tools into existing educational contexts.

The project will produce:

- Open, adaptive STEM courseware that has been improved using data to target underrepresented learners.
- Open tools to support the iterative, data-driven improvement of open courseware, via contributions from students, instructors, and broader crowdsourced mechanisms.
- A clearer understanding of the ways that these data-driven improvement approaches can support or hinder learning, particularly for vulnerable learners.
- Insights into the barriers and facilitators for sustained adoption and effective use of these TEL innovations

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Building College-Level Number Sense with Adaptive Technology

Region: Inland Empire **Institutions:** CSU San Bernardino & Riverside City College

Discipline: Math

Grant Amount: Up to $500,000

Co-Principal Investigators: Susan Addington (CSU San Bernardino) & Mary Legner (Riverside City College)

Abstract:

"Building College-Level Number Sense with Adaptive Technology" will create content that helps students develop college level number sense, concentrating on foundational and advanced aspects of measurement and units, place value, and proportional reasoning, especially approximate mental calculation. These are thinking skills not just for the next math course, but for other courses needing quantitative methods (e.g., STEM, research methods in social sciences, business), as well as for careers, financial self-sufficiency, and for an educated citizenry. Though many math instructors presume that these thinking skills have been taught and learned in middle school, in fact they require practice at the adult level for mastery. Searches for good, conceptual curriculum at the college level in these areas turn up only traditional skills instruction. Some material is available at the middle-school level, and in curriculum for future elementary teachers, but none of this material is in a form appropriate for incoming college students.

The project team will develop materials, including video-based worked examples and virtual tutor simulations, that include culturally relevant situations and examples, featuring realistic scenarios that our diverse student body finds familiar, as well as aspirational situations (such as internships or jobs at the entry level in STEM fields). The project will also include interventions to help students develop a growth mindset, improve persistence and overcome stereotype threat. The materials developed under this proposal will be made available as Open Educational Resources.

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Improving Retention in Engineering: E-Games for Active Training in Engineering Design

Region: Sacramento Metropolitan Area
Institutions: UC Davis, American River College, CSU Sacramento
Discipline: Engineering
Grant Amount: Up to $500,000

Principal Investigator: Angelique Louie (UC Davis)

Co-Principal Investigators: Jennifer Choi (UC Davis), Darnel Degand (UC Davis), Joshua McCoy (UC Davis), Will Davis (American River College), Hong-Yue (Ray) Tang (CSU Sacramento)

Abstract:
Students in engineering typically spend their freshman and sophomore years taking courses in mathematics, physics, chemistry, and fulfilling general education requirements. Major-specific training in engineering often does not begin until the junior year. A common complaint is that the first two years of engineering education are too abstract and students are unable to feel a connection between what they are learning and what a career in the discipline is like. Disillusioned students leave early in the curriculum, and underrepresented groups are disproportionately affected.

The project team believes it is critical in the first two years of education to allow students to apply their foundational knowledge to practice—to provide a more engaging introduction to engineering as an exciting and creative career option and to solidify student commitment to their selected engineering majors. Hands-on experience is well known to improve student success measures, and improved performance increases student desire to continue in their studies. Engineering design is an ideal topic to provide higher-level experiences to students, but engineering design courses can be expensive to deliver. It can also be difficult to fit another course into the already unit-heavy engineering curricula.

"Improving Retention in Engineering: E-Games for Active Training in Engineering Design" proposes to provide scalable, meaningful exposure to engineering design to lower division students by creating online game modules that will cover the basic steps of the engineering design process. The modules can be mix-and-matched for use in courses or offered to students for free play. The project team, which includes biomedical engineers, mechanical engineers, computer scientists, educators, game designers, social scientists and students, will harness online education and gaming products that they have made for undergraduate courses in Biomedical Engineering Design and Introduction to Research and create new gaming materials. Games offer an avenue for exploration that sparks student creativity, increases engagement with the material, promotes self-confidence, and allows us to implement "hands-on" design training at relatively low cost to students at California public institutions of higher learning. The project team will explore this adaptive learning tool and evaluate its impact on student learning and retention.

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California Challenges in STEM Energy Education

Region: Central Valley **Institutions:** CSU Bakersfield, UC Merced, Bakersfield College

Disciplines: Math, Chemistry, Engineering

Grant Amount: Up to $500,000

Principal Investigators: Alan Fuchs (CSU Bakersfield), Abbas Ghassemi (UC Merced), Stephen Waller (Bakersfield College)

Abstract:

"California Challenges in STEM Energy Education" seeks to reduce large educational equity gaps in STEM fields that are experienced by Hispanic and other underrepresented minority (URM) students who live in California's Central Valley. The California State University at Bakersfield (CSU Bakersfield), the University of California at Merced (UC Merced), and Bakersfield College, three academic institutions that are located in the valley and serve these students, will participate in this proof-of-concept project.

Equity gaps in Central Valley STEM education exist despite strong demand for STEM graduates in the local economy, which is largely based upon the energy and agricultural industries. The hypothesis underlying the project is that URM students have a limited perspective of their possible contributions to improving technology due to social issues, such as knowing no one in their community who is a scientist or engineer. Furthermore, when URM students enter STEM fields, they fail to see the connection between their studies and real-world problems because gateway courses in current curricula fail to make that connection explicit.

This project will introduce the concepts behind practical technical problems at the intersection of energy, water, and agriculture—problems relevant to the Central Valley—into gateway STEM courses. This will be accomplished via a novel combination of two pedagogies, flipped classroom and Process Oriented Guided Inquiry Learning (POGIL), which we call Flipped Classroom-Enhanced-Process Oriented Guided Inquiry Learning (FC-E-POGIL). The filled classroom format involves pre-class student reading assignments and the enhanced POGIL format involves a highly structured in-class format, including assigned student roles and after class homework assignments.

Implementation of these pedagogies will vary from academic institution to academic institution and from course to course. However, in all cases, the goal will be to increase student engagement so that URM STEM students will persist in their studies and thereby close the current large equity gaps. Suitable metrics will be collected during the project, and a final report that includes curricula will be produced and made available online for future scaling.

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