

VITAL/EXPANDED TECHNOLOGIES INITIATIVE FY 2019-2020 PROPOSALS

Proposal ID:

106

Division	Academic Affairs	College of Social Behavioral Sciences			5787180
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Total Amount Requested for FY 2018 **\$121,000.00**

Project Title: BRAINSSTIM: Brain Recording of Astronauts in NASA Simulations and Student Technologies for Impacted Majors (BRAINSSTIM)

Project Abstract:

The main goal of the current proposal is to fund acquiring mobile EEG equipment for measuring brain activity and stimulating brain activity via non-invasive & safe technologies that can benefit CSUSB students by offering increased opportunities of closed courses, opening new course offerings at Palm Desert, and allow students to apply these new skills to special research opportunities studying NASA astronauts in undersea space simulation studies. The four specific aims of the current proposal are to: 1) Provide increased course offerings of Psych433 (a graduation requirement bottleneck for the campus's biggest major (Psychology, which is currently impacted) 2) Offer abilities for the professor to reach more students by teaching it at Palm Desert campus by virtue of its mobile EEG technology that can be brought there, teaching cutting edge methods to new grads. 3) Enhance student research opportunities for high impact learning experiences of research projects we can use for NASA studies on astronauts in undersea research studies we are conducting. 4) Benefit all students, alumni, and community by providing campus pride & inspiration of the scientific explorations we can conduct as CSUSB Coyotes with the best scientists, explorers, and astronauts from NASA and the European Space Agency.

Challenge(s) this project will address:

There are several challenges that this project will address. The First major challenge is that the largest major of students at CSUSB is Psychology, and yet this major is "impacted", meaning that it is officially declared over-filled and no longer taking new students until our overload is graduated. One of the several courses required for graduation of seniors of Psych433: Experimental Psychology: Biology. I teach this course every year, and it only seats 20 students because of its intensive research lab skills training requirements. Every year, it breaks my heart that while I over-enroll it by a few students I simply must nevertheless turn a large number of Senior students away who need the course to graduate that year. There is simply no room because of the intensive mentoring in research involved in the course, but also because of the research equipment needed for the course is borrowed from my own personal research laboratory and only has one single unit that must be shared among 20 students at once. This drastically limits student access and limits the number of students who can take the course to graduate. Importantly, this is an incredibly innovative course that teaches graduating seniors cutting edge research and data analysis skills in human electrophysiology and neuroscience, which are tangible trade skills that has already opened doors to our students getting jobs in competitive STEM field marketplaces, graduate schools acceptance to PhD programs will full-funding fellowships, and medical schools. But the course is packed, students are unable to take it, and I am unable to offer more options for it without additional equipment being made available to serve the greater number of students. This first challenge will be overcome by supporting the acquisition of several cutting edge technologies that will expand beyond my current "single" EEG (electroencephalogram) equipment set up, and instead provide several instances of new equipment that student groups can work with concurrently. Our solutions here will also critically involve technology that permits being able to safely modulate brain activity using non-invasive brain stimulation devices called Transcranial Direct Current Stimulation (tDCS) that we can apply to improving astronaut cognition under stress while on space walks, and using sensory stimulation of brain entrainment devices that my lab has recently published to show how to improve people's memory without drugs (simple visual stimulation goggles). Students in class can learn all of these techniques, and we can then apply them to NASA research on astronauts, since I bring students to join on these missions. Overall, this challenge of an overfilled course in an impacted major can be overcome by providing more equipment that can be used to offer the course more times to more students, so that more students can graduate to reach the Graduation Initiative goals. The Second major challenge that this project will address is that the students at Palm Desert Campus simply do not have access to attend the same course offerings on research techniques and skills that students on campus have available, because most of our most technical research methodologies are heavy and connected to stationary devices in laboratories on campus, such as in the aforementioned course of Psych 433: Experimental Psychology: Biology. The current project will overcome this challenge by providing new mobile technology of EEG recording, of brain stimulation devices, of eye-tracking equipment, hand-grip dynameters, and the full suite of modern software needed to teach students how to run and analyze these research studies with the state of the art. I was a co-developer of some of the field's top analytic software for analyzing brain activity and teach this advanced skill to students in Psych 433 to great acclaim of student success, yet it requires students have access to the proper equipment and software by which to analyze it. The current proposal will fund this, and permit students at Palm Desert to have this technology brought to them via mobile technology that is light, portable, and fits within a small travel suitcase. This will, importantly, also include mobile EEG technology, which uses wireless electrode connections that do not need to be connected to a stationary computer and allows for measuring brain activity of people as they move freely around. This is also important because it allows researchers to be portable with the equipment instead of currently being literally tied (via cords) to stationary computers in a lab on campus. It will permit a professor to provide a cornucopia of modern neuroscience methods to teach students so that they can compete in the marketplace with the best candidates in the nation, just as my students on campus have already been able to successfully do. The Third Major Challenge that this project will address is how we, at CSUSB, can help contribute to the future of human space travel for a mission to Mars. Astronauts routinely suffer from behavioral health deficits and errors of cognition and have well-known effects of space radiation on the brain areas needed for learning and memory. My lab has been involved in several NASA missions studying cognition in ground-based analogs of space flight missions, and we have been invited to contribute our CSUSB research on NASA missions studying astronaut cognition in undersea capsules that astronauts live in for several weeks 60 ft below the surface while performing daily "space walks" of dive technology. We are already on-board the 2019 mission this year collecting pilot studies of behavioral data demonstrating deficits in astronaut cognition for both motor strength (hand grip) and cognition (attention distraction) after the exhaustion of these "space walks" under water, and we have been invited to participate in the next step of this project in 2020: recording brain activity and developing countermeasures of brain stimulation to stave off these potentially catastrophic errors of cognition in astronauts. A core part of this challenge is having the right technology to accomplish this in remote undersea capsules where tiny space is at a premium, weight matters, and devices must be wireless. The current proposal solves these problems, because it will provide the small, lightweight, portable technology devices needed to study astronaut cognition and to stimulate their brains as countermeasures for cognitive deficits. We will be directly applying the research methodologies of our students in my lab courses, studying learning, memory, motor coordination, brain stimulation, and eye-tracking, to astronauts from NASA and ESA (the European Space Agency) at this very special mission that only happens once per year and at one place on the planet (the NEEMO Mission, in Florida). We will have this technology, optimally suited for the project, tested out and developed by our own CSUSB students. I am already taking CSUSB students with me to NASA for these behavioral pilot studies in 2019, and the current funding will permit us to continue this work to take even more CSUSB Students to the mission in 2020. This enhances student research opportunities for high impact learning experiences of research projects, enhances student career development, career networking and opportunities in ways otherwise generally not possible. It brings CSUSB research to the international stage as our students will help to capture astronaut cognition while working in undersea space capsules preparing for trips to Mars, the Moon, and beyond. The fourth major challenge that this proposal will address is, quite simply, by serving these aforementioned challenges above, also serve to inspire our entire campus of students and our broader community of alumni & citizens in the Inland Empire. Many of our students do not believe in themselves and lack the confidence in what our true potential and capabilities are as San Bernardino Coyotes to excel on the national stage. We do not always realize what we can accomplish right here at home by our work in the Inland Empire, and what our colleagues are already accomplishing via hard work. We all need constant reminders and inspiration of what can be done, and that we can do it. Our larger community benefits when seeing that this can be done at CSUSB, and gains pride in our local community as being world leaders. By the visibility of seeing that our faculty and students can lead among the world with international partners to work with NASA in studying astronaut cognition in these special opportunities that are so rare, we highlight not just our own work in this mission, but reflect everyone's broader work in the San Bernardino Community that makes this all possible, because we are one Big Team together.

Alternate solution(s) should this project not be funded:

Some alternative solutions if this project is not funded could be to hire more tenure-track faculty capable of providing the rich in-depth learning experiences of the graduation bottle-neck course of Psych433 both on campus and at Palm Desert. It could include purchasing more required equipment via those start-up funds or other funding mechanisms such as via Open University funds since these students also take these courses. We can also apply for additional external grants (currently in-progress), but these cycles can take years of re-submissions at the federal trough with major R1 competitors and simply cannot be relied upon in uncertain funding times. For our NASA mission research, alternative solutions could include scaling back our research to omit brain measures and countermeasure stimulations, but this would de facto remove our research prospectus from their agenda since it is our main hypothesized contribution, though it is possible that we could do the simpler brain entrainment procedures we have recently published (Roberts et al., 2018, Cognitive Neuroscience). In terms of our 4th goal of inspiring our campus & community with what is possible to achieve at CSUSB, if this project is not funded, then we will simply continue to do our best working hard in our local ways on campus to do research and connect without local community, but it will not be able to have the same spark to capture the imaginations of our citizens that working off-site with NASA astronauts inherently will have to our community members who care about such things.

Impact(s) if this project is not funded:

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There are limited alternative solutions to these challenges if this project is not funded. The current course offering of Psych433 is intensive and only once per year for this research kind, and only to 20 students in the largest & most impacted major on campus. If students do not get this course they are delayed in graduation if they can find no other viable alternative, and we as an institution are slower in reaching the Graduation Initiative. Likewise, the equipment for this course are simply not available for being portable to other locations such as Palm Desert because the current equipment is older and is literally connected to large stationary computer devices by extensive cords. So, without the mobile technology, this can not be offered there, and if we installed costly stationary devices there then we still lack the professional experts of instructors there who can teach from it effectively. These Mobile solutions solve multiple problems at once. Accordingly, the equipment needed for the NASA research project in 2020 may not be available should this project not be funded. Indeed, I currently have several other grants submitted and pending to help support these aims from federal agencies, and more planned to submit in the future, but as everyone knows, federal funding agencies are notoriously fickle and can not be relied upon in uncertain funding times. Furthermore, and more practically, these external mechanisms tend to take several costly rounds of revisions and re-submissions that can take up to multiple years to accomplish, whereas participating in these special NASA research studies takes being in the position of having funds in-hand in order to support these costly endeavors or risk losing mission access. But the cost is far outweighed by the benefits- not just to humanity's goal of space exploration but also to our student experiences of gaining world-class opportunities they can get nowhere else but at CSUSB.

Cost: \$\$ (One time or recurring)

One time. A budget estimate has been provided and uploaded. Briefly, the costs detail each piece of mobile equipment to create a dynamic research lab course with the most current and cutting-edge technologies for our CSUSB students interested in psychology and neuroscience. The laptop computers are needed for their mobile nature to inherently pair with the mobile EEG, mobile tDCS, mobile eye-tracking goggles, and the mobile hand-grip dynameters that are all equally important requirements for conducting our integrative neuroscience studies that combine motor coordination of grip-strength to measure competition of physical resources with mental resources of cognitive load during memory and attention tasks. These require basic supplies that are included in the budget, and software that is frankly essential to completing this work (Matlab does the critical analysis of the data, while Presentation does the important stimulus delivery to participants), and can be provided to students to work from their laptops so they can practice their skills with homework away from campus computer labs. Additional funds for supporting time critical for supporting projects include faculty release time in preparatory quarters so as to be able to guide the lab team of students to prepare for the mission and preparing the 433 course, and supporting student involvement with salary for student time so that they do not need to divide their attention between school and employment, focusing on academics and science instead.

What are your intended Process Outcomes and/or Student Learning Outcomes?

Process Outcomes goals from the current project include visible improvements in the number of students who can take our course offerings, which can translate to the improved number of students graduated, our increased ability to reach the graduation initiative and open up the psychology major from its status of being impacted. We can also hope to see increased student participation in research offerings at Palm Desert Campus, and increased student participation in research at off campus sites like our NASA research study. This can lead to major outcomes such as graduate student admission to PhD programs and other high impact professional careers in STEM fields of science. Overall, we also seek to find students more inspired by their CSUSB education, more confident in their own abilities, and more proud of our collective San Bernardino community. There are several Student Learning Outcomes of the current project. The main Outcomes targeted here match those of the Psychology Department's Masters in Psychological Sciences guidelines, which are generally and specifically met by virtue of the proposals emphasis on a lab research course that integrates both writing, practical 'doing' and communicating, plus the professional development skills of students required to represent us all from CSUSB while at NASA.

Assessment Plan and Key Performance Indicators (KPI) (Measurable/Verifiable)

Assessment plan and key performance indicators from the current project include visible improvements in the number of students who can take our course offerings, which can translate to the improved number of students graduated, our increased ability to reach the graduation initiative and open up the psychology major from its status of being impacted. We can also hope to see increased student participation in research offerings at Palm Desert Campus, and increased student participation in research at off campus sites like our NASA research study. This can lead to major outcomes such as graduate student admission to PhD programs and other high impact professional careers in STEM fields of science. Overall, we also seek to find students more inspired by their CSUSB education, more confident in their own abilities, and more proud of our collective San Bernardino community.

Project Timeline **Start:** 9/1/2019 12:00:00AM **End:** 6/30/2020 12:00:00AM **First Quarter of Student Use** Fall 2019

Statements of support by collaborating organization(s) or department(s) (if applicable)

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