

## ACTIVITIES AND PROGRAM MODEL

# Authentic Marine Research Experiences for Low-Income and First Generation High School Students Used to Level the Playing Field and Decrease Attrition in STEM

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Summer research experiences are often life-changing for first generation high school students of color, especially in the marine biology field. The University of Southern California (USC) Leslie and Bill McMorrow Neighborhood Academic Initiative (USC NAI) partners with STEM professionals, laboratory scientists, local marine-based field sites, marine educators, and laboratory managers to facilitate hands-on, inquiry-based research and learning experiences for the high school students that participate in their program. These partnerships collaborate with instructors to deliver an ocean research methods course to the students. The learning goals of the course include providing the foundational scientific skills needed to succeed in the STEM workforce and learning about various marine related careers. As a result of the ocean research methods course and other STEM interventions with USC NAI, 42% of NAI grads who have gone to USC have declared a STEM major as freshmen since 2013.

**Keywords:** URM; STEM; Authentic Research Opportunities; DEI



**Figure 1:** A group shot of the 2018 scholars on the dock in front of the Miss Christie boat that brought them to Catalina. Photo: Dieuwertje Kast. Reproduced with permission of the photographer.

## Introduction

The nexus of racial and economic segregation has intensified educational gaps between affluent and low-income students, and between white students and students of color (Meato, 2019). The educational divide limits economic advancement and professional opportunities and denies people of color from lower socioeconomic income brackets access to highly specialized fields such as marine biology, conservation biology, and SCUBA diving (Scott, 2020). To diversify marine science and policy and conservation institutions, then we must address the educational barriers and exclusionary practices upheld in these fields for people of color (Scott, 2020). Recent data from the most recent National Science Foundation report on Women, Minorities and Persons with Disabilities (2016)

*finds that out of the 620,489 total enrolled science and engineering graduate student population, only 36 (0.1%) were in ocean sciences. When broken down further by sex, of the 17,630 enrolled black female graduate students, 551 studied biology and only 18 ocean science, representing <0.1% and <0.003% of the entire enrolled science and engineering graduate student population, respectively (p.5)*

Minority groups can feel excluded from the marine biology field because of differences in culture, personality, economic background, and prior opportunities to experience the marine or freshwater environment (Pickrell, 2020). Something as seemingly simple as swimming can be an implicit gatekeeper to the marine biology field. These inequities and inequalities limit access to fields like science and marine biology, and these barriers need to be addressed on a systematic level.

One of the ways these educational barriers can be addressed specifically for high school students is a summer research experience. High school students that participate in a summer research experience develop foundational science knowledge and processing skills, can increase in science self-efficacy, and begin a lifelong commitment to scientific inquiry that can decrease attrition students face in their freshman year in college (National Academy of Science, 2011; Boyer, 1998; Dirks, 2006). To support persistence in first generation students in STEM, program interventions should include: “strong opportunities for research participation; participation in special workshops, seminars, and courses; careful academic and career advisement; and incorporation into the campus scientific community through the interaction with science faculty, academic and industrial scientists, and other successful science students” (Estrada, Burnett, Campbell, Campbell, Denetclaw, Gutierrez, & Zavala, 2016, pg 6). Furthermore, it is crucial to develop a mindset that college is attainable and accessible to further support first-generation and minority students’ persistence within STEM (Saunders & Serna, 2004).

Field research experiences offered at field stations and marine laboratories are often life-changing for many students because they provide a highly specific venue for actually doing science and for experiencing inquiry-based learning (Klug et al., 2002). Creating linkages between groups who are underrepresented in ocean sciences to research centers such as marine laboratories and oceanographic institutions is an important strategy to ensure an innovative and diverse future ocean workforce (Gilligan, 2007).

## Partnerships for the Research Methods Course

To produce systemic change and transformative outcomes for underrepresented minority (URM) STEM students, there are important factors that need to be considered; among them, strategic partnerships and understanding the context and background that one’s students come from (Elrod and Kezar, 2015). In 2013, the USC McMorrow Neighborhood Academic Initiative (NAI), a college preparatory program for first generation and low-income students in Los Angeles, launched a summer marine research methods course that combined all these ideals **Figure 1**. This program included various partnerships over the years including the USC Wrigley Institute for Environmental Studies (WIES) on Catalina Island (a field site), Cabrillo Marine Aquarium (CMA), research vessels including the E/V *Nautilus* and the *JOIDES Resolution*, and more. The lead instructor of the course partners with university-affiliated STEM professionals, laboratory scientists, local marine-based field sites, marine educators, and laboratory managers to facilitate hands-on, inquiry based research and learning experiences for the high school students that participate in their program. Furthermore, the classes were hosted mainly in university laboratory spaces to support the mindset that these are spaces in which the students belong and reinforce the mindset that STEM at the undergraduate level is accessible and attainable.

### **USC McMorrow NAI Program Description**

USC Leslie and Bill McMorrow Neighborhood Academic Initiative (USC NAI) is an academically rigorous and comprehensive seven-year pre-college program designed to prepare students from south and east Los Angeles for admission to a college or university.

*Under the program guidelines, students must commit to a seven-year plan of attending Saturday Academy classes along with weekday morning classes at USC, after-school tutoring and parent workshops. Parents are also required to attend a biweekly Family Development Institute program to reinforce student academic goals and study habits and maximize a healthy home environment. Students who remain in the program in good standing from sixth grade until their high school graduation are eligible for a fully funded financial aid package- minus loans, to USC, provided they meet admission requirements. The USC McMorrow Neighborhood Academic Initiative (NAI), the university's signature college prep program enrolls close to 1,000 students annually. The USC McMorrow NAI program also provides support to all NAI Scholars through their first college degree. Since its first graduating class in 1997, more than 1300 students have completed the program with 83 percent enrollment as freshman at four-year universities, and 42 percent enrollment at USC (NAI, 2020)*

From 2013 to 2019, the USC NAI program had an average student population of 86% Latinx, 12% Black, 1% Asian/Pacific Islander and 1% Other. USC NAI's program focus is college preparedness in all fields, but in 2013 the program leadership saw a need to support their students in STEM based initiatives and help them persist in STEM fields. They received an initial grant from the Toyota Foundation to add a Saturday Science component to its program model. Based on some of those relationships, the ocean research methods course was born. After adding science as a core program component, the students of the program began demonstrating an interest and desire to engage more deeply in science. Thus, this course emerged and was added to the catalog of summer electives that the NAI scholars can take, and they self-select each of their respective courses. The course includes many opportunities to connect with field research sites and travel to places participating NAI scholars generally have not accessed before, like the beach, a research boat, or Catalina Island (a field experience).

### **Field experience to Catalina Island**

During many of the previous seven years of the program, we have partnered with educators and staff at a university-affiliated marine and environmental biology field site on Catalina Island to host a field site visit and execute the scholars' research experiments. For many of the scholars, the boat ride to the field site is their first ride on a boat. The research projects were facilitated by the educational staff and focused on studies that could be executed in the short time frame of the site visit **Figure 2**. The site visit included not only the execution of the experiments, but also a heavily chaperoned snorkeling experience with the leopard sharks in Big Fisherman's Cove (part of a Marine Protected Area located adjacent to the USC Wrigley Institute). The



**Figure 2:** NAI scholars from the class of 2017 executing their research projects at the field site on Catalina Island. Left: An NAI scholar using a refractometer for a water quality research project Right: A NAI scholar analyzing plankton under the microscope for her plankton research project. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.





**Figure 3:** NAI scholars from the class of 2016 snorkeling in the ocean water near the field site on Catalina Island. Photo: Dieuwertje Kast. Reproduced with permission of the photographer.

students also sit with graduate students in the cafeteria and see what a communal science space looks like. For many of the students, this field trip was their first experience swimming, let alone snorkeling **Figure 3**. Wrigley provides educational staff at an eight-students-to-one-staff-member ratio. All safety considerations for snorkeling and boat transportation were considered and accounted for, with lifeguards, safety equipment, high student-to-staff ratios, and parental release forms for their participation in the research excursion.

Examples of the research projects that have been executed at the field site have varied between year to year and have included plankton population comparisons of the dock compared to the beach, fish respiration in the salt-water aquariums, transects in various habitats around the cove that the students snorkel over for fish counts, underwater remote operated vehicle testing, and feeding preferences for various marine organisms. Lorraine Sadler, Woman SCUBA Divers Hall of Fame inductee and an educator at Wrigley Institute for Environmental Studies, said:

I support the students by setting up the research projects here on Catalina Island. I work with the students so that they will learn fundamental research protocols and be able to collect data at our field site. Building these skills helps them to think critically and in a scientific way. I love seeing the light bulbs go off during their day trip because I know that they will be building upon these scientific research skills. We think it's crucial to be able to give access to the ocean as part of this trip. Many of the students have little to no water experience and some have not been to the beach or on a boat and for most of them, this is their first time snorkeling. The educational staff works to reduce their fears by demonstrating how the gear works and that it won't allow them to sink.

Without the support of the educational staff out at the USC Wrigley Institute, day trips to collect data and snorkel would not be possible.

### ***Guest Scientists***

Another partnership the ocean research method course has created is with scientists all across the United States from various backgrounds and representative of the participating student population. The scientists spanned a variety of underserved contexts in STEM including a variety of race, genders, orientations, ability, and more and also intersectionality within those contexts.

One of those scientists was Dr. Dijanna Figueroa, who spoke to the NAI scholars as a guest scientist in 2018 and continued for the years following **Figure 4**. She was an amazing role model for the students. She has a BS in marine biology (UCLA) and a Ph.D. in marine science (UCSB). She shared her experiences as a marine



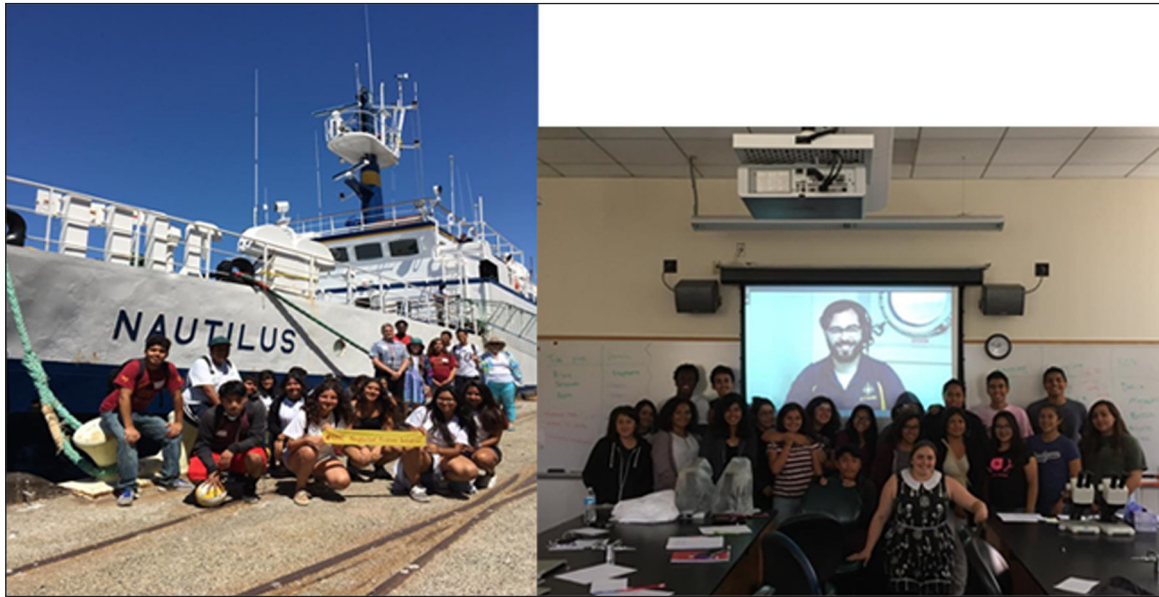
**Figure 4:** NMEA Expanded Audiences Co-chairs Dr. Dijanna Figueroa and Dr. Dieuwertje Kast. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.

scientist and educator who has spent over 15 years investigating deep sea ecosystems and developing new research instrumentation for deep sea exploration. She talked about how her research had been featured in science and nature programs and various media outlets, including James Cameron's documentary, *Aliens of the Deep*. She is one of the few African American women who has descended more than 3,722 meters in the deep sea! In 2006, she began to focus on education. She believes in the power of hands-on education and has become a maker mentor. She has experience teaching science, engineering, and STEAM in K-8 schools throughout greater Los Angeles. She is a member of the Maker Education Initiative Maker Corps. She is committed to providing engaging learning opportunities for young people that help prepare them for the science and technological discoveries of the future. By meeting scientists that look like our students, students develop an identity internally as a scientist themselves.

### **Research Vessels**

E/V Nautilus: Stemming from the Lead Course Educator's participation as a Science Communication Fellow (SCF) aboard E/V *Nautilus*, the class also dove into learning about deep sea exploration **Figure 5**. The Science Communication Fellowship immerses educators as expedition communicators for at-sea ocean exploration research. The yearlong collaboration empowers Fellows to bring the science, technology, engineering, math applications, and careers of maritime research to students and their communities. Students connected with SCF colleague Dennis 'DJ' Pevey aboard the ship for a live conference to learn about the ongoing expedition to map the seafloor. He stated:

Interacting with the USC NAI was one of the highlights of my experiences aboard E/V *Nautilus* during the 2016 expedition season. Through a live satellite connection with the ship, the students and I were able to experience the wonder of discovery together while viewing live footage captured by the ship's two remotely-operated vehicles (ROVs). During that sequence of dives, the ship's main scientific mission was to map and visually survey populations of deep sea corals in the proposed site of a Marine Protected Area called California Central Coast Chumash Heritage National Marine Sanctuary. During our interaction, the students and I were treated to some of the first-ever video footage of an incredibly diverse marine ecosystem thriving deep under the waves near their homes. Upon returning to shore, the students had an opportunity to meet the rest of the science team and see some of the samples we brought back from those dives.



**Figure 5:** Left photo: NAI Scholars in 2016 standing in front of the E/V *Nautilus*. Right photo: NAI scholars and the lead instructor pose with Ocean Exploration Trust (OET) Science Communication Fellow (SCF) DJ Pevey Photos: *Dieuwertje Kast. Reproduced with permission of the photographer.*

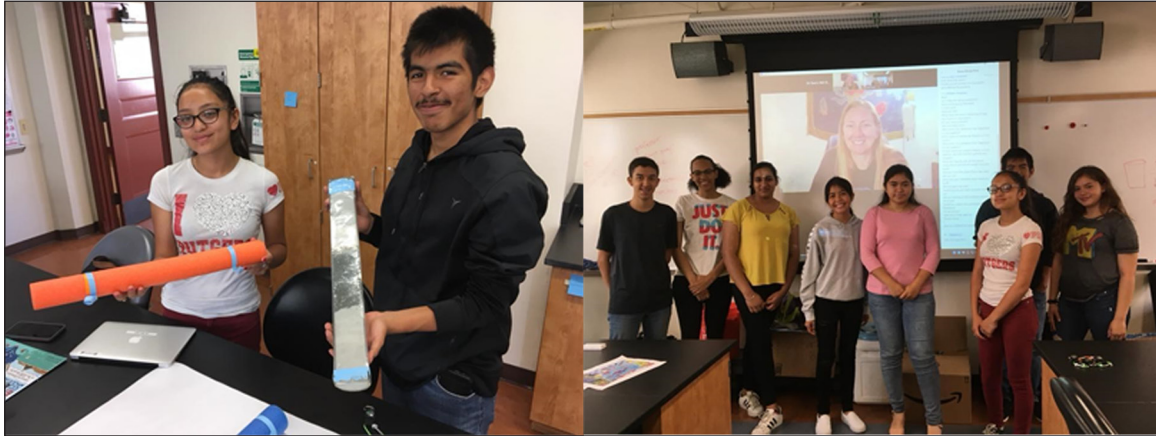
Anyone can connect to deep sea expeditions 24/7 online through telepresence livestreams, but NAI students had the chance to tour the unique workplace of a research vessel as the ship came into port in San Pedro. Experiencing the collaboration and cooperation required to stage ocean-going missions reinforces practices from the classroom and problem-solving taught in STEM challenges. Live ship-to-shore video conferences and public virtual events hosted by OET engage students in a two-way dialogue with scientists, engineers, and educators at sea to bring the excitement of discovery into the classroom or home. These programs are free to learners worldwide. Learn more at <http://nautiluslive.org/education>. Students were able to virtually interact with scientists and science communicators who worked on the ship before the field trip and meet them in person during our tour of the vessel when it was in port. The tour demonstrated some of the research spaces that scientists live and work in while they are in the field, which further demystified what a field marine scientist experiences during various stages of their careers. This experience was tied to the application of ocean literacy principle #7 stating that the ocean is largely unexplored and the mission of the *Nautilus* and the dissemination of its research works to explore the deep sea environment.

### ***JOIDES Resolution***

**JOIDES Resolution:** During the 2018 class, the USC NAI research methods course instructor partnered with educators onboard the *JOIDES Resolution*. They videoconferenced with an onboard outreach officer named Tammy Orilio, who discussed her experience translating science onboard the ship to informal and formal audiences around the world **Figure 6**. She was on the *JOIDES Resolution* Expedition 376, when scientists drilled into the hydrothermally-active Brothers Volcano, located about 300 miles northeast of the north island of New Zealand, from May to July 2018. Brother's Volcano is part of a chain of volcanoes (also known as a "volcanic arc") that is about 4,000 feet beneath the ocean's surface) and releases heated fluids, metals, and other dissolved chemicals into the surrounding seawater. Orilio also connected and applied the ocean literacy principle #7 of the ocean being largely unexplored and explained how the cores they collect work to explore the ocean floor. Orilio said:

As Education & Outreach Officer on board the *JOIDES Resolution* for this expedition, I was able to video conference with classrooms around the world, including the NAI Ocean Research course, to explain what the science team was working on. Students learned about submarine volcanism, bathymetric maps, and the technology used to make those maps. The kids had such great questions about not only the science being conducted, but also how life on a ship works when you're there for two months. It's all about making connections and making science come alive! The students were immersed in real-life science, even from a distance, and were able to see that all science is not done by men in lab coats working in a sterile environment. Hopefully, that sparked something in them and they realized, "I could do this, too!"





**Figure 6:** Left photo: Core Sample from JOIDES Resolution and simulation activity. Right Photo: Tammy Orillio video-conferencing as an “Educator at Sea” from the JOIDES Resolution during expedition 376. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.

The expedition focused on drilling cores from the Brothers volcano in the ocean near New Zealand. This was followed up by a visual examination of an amazing replica core that Nicole Kurtz sent over. The students compared this replica to a do-it-yourself (DIY) foam noodle core with magnets inside to illustrate the consequences of having high iron content in a core and see the effect on its orientation on the compass. Additionally, Dr. Lisa White sent the lead instructor open ocean foraminifera samples that students were able to examine under the microscope. This correlated to how the cores represent geologic history accurately since the ocean floor has pristine fossil and microfossil records from millions of years ago. This experience demonstrated other career options underneath the umbrella of marine science, including geoscience, marine paleontology, earth science, and geology.

### Informal Science Institution Partnerships

Two of the courses partnered with informal science institutions, including USC Sea Grant (specifically Linda Chilton, the education manager from USC Sea Grant) and the Center for Deep Energy Biosphere Investigation (CDEBI). Chilton said: “[The instructor and I], we collaborate and plan [activities so that] students have the resources they need, such as using the build your own ROV materials. [Students] are able to apply engineering, design, and problem solving all in developing skills they will use in the field at Catalina.” All safety considerations are taken into account with the batteries and the waterproof wires to make sure all of the students safely participated in making and controlling the ROVs in a local water fountain on the university’s campus **Figure 7**.

The Cabrillo Marine Aquarium was another informal science institution partner that has hosted some of our research projects in the past, including kelp holdfast dissections, transecting and assessing the sandy beach environment for sand crab populations, and collecting bird watching data at their local estuary **Figure 8**. Carl Carranza, Aquarium Educator I at Cabrillo Marine Aquarium, stated:

All of us at Cabrillo Marine Aquarium enjoy collaborating on projects like this and with fellow educators. They reach a population of learners who, for one reason or another, cannot make it down to us for our onsite programs. This kind of teamwork helps more students to not only learn about the ocean, but also to discover what a fabulous and accessible resource it is for everyone, no matter where they live.

Partnerships with informal science educators and institutions diversify the opportunities the students are presented with during the course. They provide opportunities for hands-on exploration and the chance to explore another avenue of potential career choices. Furthermore, these experiences reinforce ocean literacy principle #6 that the ocean and humans are interconnected in a variety of ways.

### Course Development and Learning Goals

The ocean research methods course was developed to address the issues of equity and inclusion mentioned above. Partnerships were developed with authentic STEM experts and a university affiliated field site. The content covered in the course includes climate change, ocean acidification, underwater robotics



**Figure 7:** Left photo- Scholars from the Class of 2015 put together the CDEBI robotics kits to make their own underwater robotic designs in the lab. Right photo – the NAI scholars test their designs in the USC Leavey Library Fountain. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.



**Figure 8:** Left photo: NAI scholars perform a kelp holdfast dissection donated by Carl Carranza in Cabrillo Marine Aquarium in 2015. Right Photo: A Hermissenda nudibranch found during the kelp holdfast dissection. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.

**Figure 9** and engineering design, ecological habitats, buoyancy, and the intersectionalities of all of those topics. Furthermore, the content also incorporates and applies many of the ocean literacy principles, including the interconnectedness of the ocean on Earth, the diversity of life and ecosystems in the ocean, and that the ocean is largely unexplored.

The learning goals of the course are not necessarily focused on the content but more on the pedagogical science content knowledge of how to do research. We focus on the nature of science and empower students to think like a scientist through inquiry-based experiments and the research projects they complete during the course.

The main learning goals of the course included

1. Providing access to STEM spaces that are not available or present in their high school settings
2. Offering students authentic research opportunities in university undergraduate labs, field sites, and professional industry laboratories.
  - a. Focuses on science communication and methodology skills
3. Exposing students to scientists from various STEM disciplines under the umbrella of marine science
4. The course instructs students on how to do scientific research, which includes covering components of the nature of science and the scientific method.





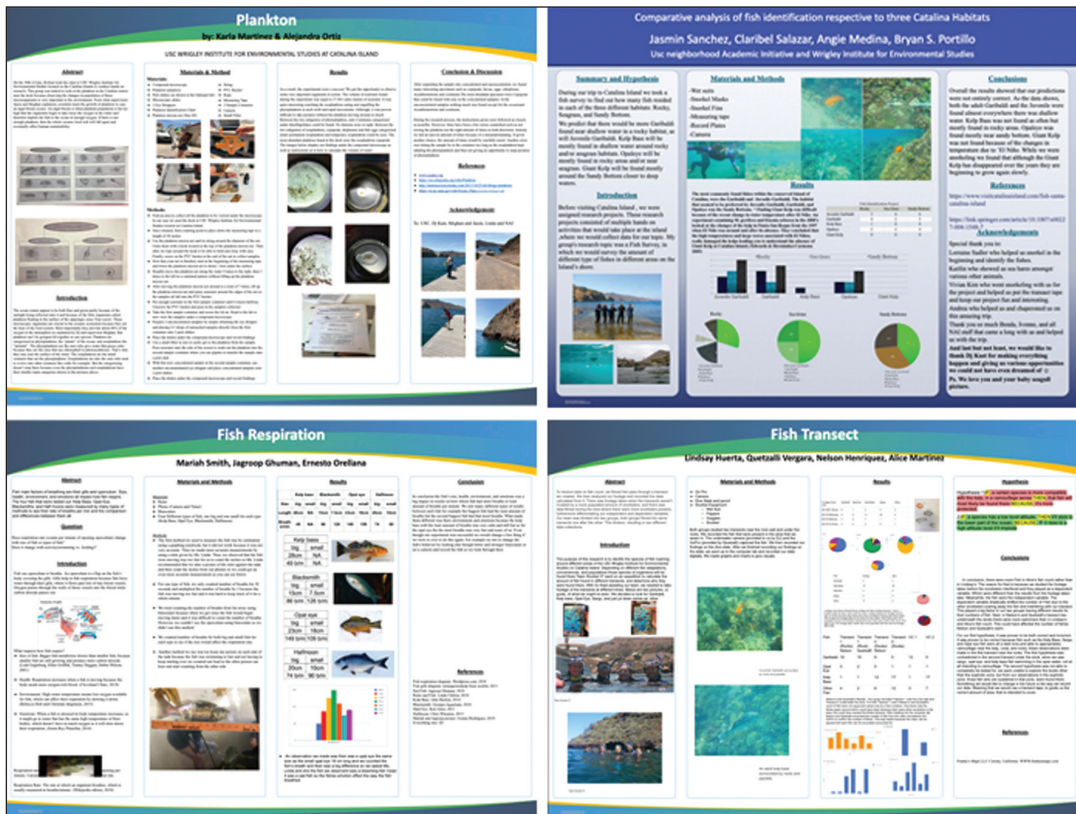
**Figure 9:** NAI scholars from the class of 2015 place their ROVs into the fountain in front of Leavey Library. Photo: Dieuwertje Kast. Reproduced with permission of the photographer.

Learning how to conduct scientific research is a main theme of the course. Students are taught the scientific method. The students are given main research topics that the field sites are able to facilitate data collection for. Students are responsible for creating hypotheses and for researching the background information and materials needed for their particular study. They collect data at the field site and on the days following, spend time on data analysis, look for patterns and trends in their data, and finalize it with the overarching themes in their conclusions. Students learn how to be able to communicate like a scientist does at a conference by creating a poster using a scientific poster template. The course culminates with a symposium where the students present their scientific posters to their classmates, program staff, university faculty, and STEM professionals, who come in and observe and give constructive feedback and inspire them to continue doing similar work. The posters represent the summative assessment for the course. Below are some examples of student presentations **Figure 10**.

### ***University Laboratory Spaces***

The course itself is hosted within the undergraduate and graduate biology laboratories so that the high school students are learning in an authentic science space on a college campus. Historically, students from lower-income backgrounds are markedly less likely to enroll in the full sequence of STEM courses offered at





**Figure 10:** Screenshots of the scientific posters the students made for the research symposium. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.



**Figure 11:** NAI Scholars dissecting a dogfish shark that was donated by Gorjana Bezmalinovic and Arunima Kolekar for a comparative physiology dissection in 2019. Photo: Dieuwertje Kast. Reproduced with permission of the photographer.

their high schools and are consequently less prepared for STEM careers than their more advantaged peers (Jury, Smeding, Stephens, Nelson, Aelenei, & Darnon, 2017). Furthermore, there are numerous structural barriers that stand between lower-income students and STEM preparation in high school including access to high-quality laboratory learning spaces. The high school these scholars come from only offers one Advanced Placement (AP) STEM class, AP Biology, which is a stark contrast to their more advantaged peers whose high schools offer 15 to 20 AP courses. By having the course in undergraduate laboratory settings, the students receive exposure to more skills and tools that will lay a foundation for them to persist in the STEM field of their choosing **Figure 11**. Gorjana Bezmalinovic, the laboratory manager that USC NAI partners with, to aid in this undergraduate laboratory access said:

“As the laboratory manager of the USC’s undergraduate biology classes, I think it’s crucial to give back to the community however we can. We do it by offering the NAI students laboratory spaces on a university campus for a research methods course. We offer the space and provide some equipment for the students to use. We provide the space so that those high school scholars can feel more prepared to be science majors in the future. It gives them a glimpse of what science looks like at the college level at the end.”

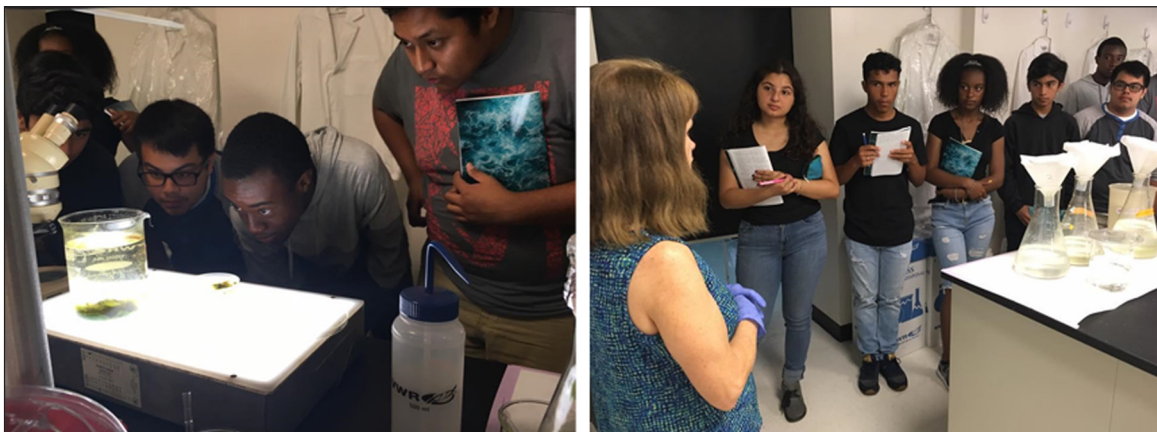
By working in the undergraduate lab spaces, we invite students to feel welcome in a university campus community and in STEM classrooms. Furthermore, Arunima Kolekar, a senior laboratory technician who supports the course said,

“USC NAI is a great way for USC to use its resources to help address the lack of socioeconomic diversity at the college level. It allows students from disadvantaged backgrounds to not only envision a brighter future, but also it helps them actively work toward it. Working with the NAI summer program is a great way for our department to be able to donate our extra lab materials and supplies, as well as our physical lab space, to students who might not otherwise be able to spend time in a lab environment and get hands-on experimental experience. I think USC NAI is a really meaningful way for USC to form partnerships with local schools and the community and help these bright and accomplished young people accomplish their goals.”

By bringing these students into the partnership with the university laboratory spaces, we work to level the playing field for the NAI scholars to succeed and decrease their attrition in STEM disciplines.

### ***Professional University Laboratory Visits***

University-affiliated partners have also included marine scientists who graciously invited the high school students into their laboratory spaces on campus. Two of those scientists include Dr. Suzanne Edmonds and Dr. Carly Kenkel. We prioritized visiting female scientists and scientists of color so that the students could see themselves represented in the scientists we placed in front of them.



**Figure 12:** In 2017, NAI scholars visited Dr. Suzanne Edmonds’ lab. Left photo: Scholars are looking at copepods in a beaker. Right photo. NAI scholars talking with Dr. Edmonds. Photos: Dieuwertje Kast. Reproduced with permission of the photographer.



Dr. Suzanne Edmands' lab studies conservation, population, and evolutionary genetics using a combination of fieldwork, molecular genetic analyses, and controlled breeding programs. Much of their current work involves using the tidepool copepod *Tigriopus californicus* as a model for understanding the genetic basis of reproductive isolation and environmental stress tolerance. Students met with Dr. Edmands' graduate students in the lab to learn about their STEM experience and see copepods for the first time **Figure 12**. Dr. Edmands stated:

"It's always a pleasure to have NAI scholars tour my marine genetics lab. They invariably ask perceptive questions and seem genuinely excited about looking at tiny marine animals under the microscope! I hope these visits will encourage students to consider pursuing a career in scientific research."

The scholars of the class of 2019 visited the lab of Dr. Carly Kenkel, a Gabilan Assistant Professor of Biological Sciences **Figure 13**. Her graduate students study ecology or organism-environment interactions by inducing or selecting for different phenotypes and how these ecological interactions influence and are influenced by the evolutionary trajectories of populations and species. Her research focuses on understanding why some coral animals are capable of withstanding environmental stress that causes others to bleach and die and how we can use this knowledge to manage and restore reefs for the future. Dr. Kenkel and her graduate students use both lab and field experiments and measure everything from environmental data, to microbes living around and inside the coral, to the physiology and genetics of the coral itself. Dr. Kenkel described the experience:

"The NAI students visiting my lab learned what corals are and what coral bleaching means. They were able to see live coral and their cousins, anemones, in our on-campus aquarium room, view some of the tiny algae that live inside a coral's tissue and are the key to the bleaching response, and touch coral skeletons. I hope that in learning about coral and the important role they play as the foundation of coral reef ecosystems, the NAI students were able to take away a greater appreciation for these remarkable organisms and how they are threatened by climate change."

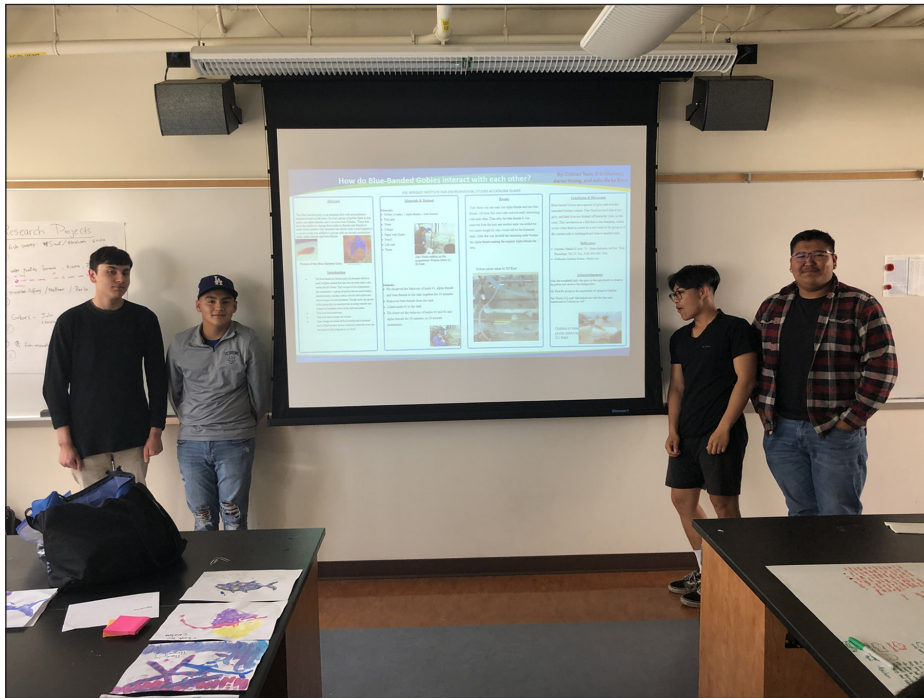
By having access to these authentic laboratory spaces and meeting with scientists in the field, students are able to see what types of careers are available if they want to pursue careers in the marine biology field. The students also become familiar with the tools of the scientists' world and consequently become accustomed to working in a lab space, thus demystifying science as a discipline for their future careers.

## Impact

The impact of the course cannot be underestimated. The course has been taken by more than 150 students over its six-year tenure. The course assessment and evaluations have been mostly qualitative and experiential-based for a gamut of reasons. Low-income students find the high-stakes assessments in STEM courses to be stressful and anxiety provoking which can lead to underperformance and compromise students' ability to advance in STEM (Rozek, Ramirez, Fine, & Deilock, 2019). Instead of quantitative assessments, the students



**Figure 13:** Scholars admire the corals in Dr. Kenkel's lab. *Photos: Dieuwertje Kast. Reproduced with permission of the photographer.*



**Figure 14:** One of the scholar research groups presents their research project with a scientific poster at the 2019 research symposium. *Photos: Dieuwertje Kast. Reproduced with permission of the photographer.*

work towards a summative assessment of a scientific poster that culminates the weeks of hands-on STEM and applies contextually the research experiences they've been involved in **Figure 14**. For example, the symposium provides a venue to demonstrate both their newly learned scientific skills but also their science communication of the research they have performed. Additionally, in line with anti-racist pedagogies, this article works to give various stakeholders in the course a voice, which includes students, family members, instructors, administrators, and supporters.

The course works to support persistence in STEM throughout their high school and undergraduate careers and beyond. One narrative from a current undergraduate student in STEM and NAI alumni, Jasmin Sanchez, illustrates the experiential impact the course had on her STEM career.

"I loved this course so much that I took the class twice, because one time was not enough. The course exposed all of us to marine biology and how science can be applied to everything around us through a research lens. Before the course, I had no clue what research was or all it entailed, I don't think many of my classmates knew either. The course immersed us into the field of science by having us read about the subjects we were inquiring about, creating a hypothesis about what we think could happen through group discussions, formulating our predictions together, and then creating our experiment. By the end of the program, each of our groups had a research project that we presented to one another. It was a very different way of experiencing science, especially for my classmates who have only learned about science through textbooks. Through the entire process our instructor pushed us to learn more about science and professions within the field. It helped us stray away from the idea that being a scientist doesn't mean a person has to be a doctor, nurse, or the normalized grand professions. Science is much greater than that, and it can be found anywhere.

I loved the work of this course so much! It truly impacted who I am as a person. After I graduated high school, I was selected to attend USC as a STEM major. In my first semester at USC, I became part of a research team that focused on understanding how sugar affects the brain. It was amazing and it taught me so much that I had to continue pursuing research opportunities. As a junior, I applied and was accepted into the Research Gateway Scholars, a program at USC that lead instructor Dr. Kast recommended me for. The research I am currently working on revolves around the idea of peacebuilding in South Los Angeles communities with students from the community. I am working closely with occupational scientists and therapists who work on preventative interventions.

I remember how much this course focused on the fact that science was the foundation of everything we learn. I can truly agree with that today. I took this course several years ago and I still find myself reiterating the information I learned back then, in the present.

Today, I am in the process of pursuing a graduate degree program in occupational therapy. This course opened the doors for me and allowed me to find something I love and care deeply about. Dr. Kast encouraged me to pursue science six years ago and continues to do so today. She is my mentor and I am and will always be eternally grateful to her."

Many of the students over the years have similar narratives in regards to impacts of the course. Course leaders aim to quantify both the qualitative and quantitative impacts in the course for future evaluation and assessment measures. The program director of USC NAI, Dr. Lizette Zarate, had this to say about the courses' impact:

"Exposing our scholars to various disciplines is a hallmark of the NAI program. During the summer we are able to partner with different professors and programs that offer our scholars immersive experiences. We've had classes taught by business school professors, a cinema workshop led by the renowned faculty of the USC School of Cinematic Arts, guitar, art, etc. One of the most popular every summer, however, is the Marine Biology course led by Dr. Dieuwertje "DJ" Kast. Since 2013 she has taught this hands-on research class that places our scholars in the USC labs, engages them in inquiry-based science, and culminates with a trip to the USC Wrigley Institute on Catalina Island and a poster session led by the students. Dr. Kast masterfully engages the scholars and makes marine biology accessible. Her class has been an asset to our course catalogue, as it allows us to pique or nurture an interest in our students and has a long waiting list. As a result of Dr. Kast's class, many of our scholars have gone on to pursue STEM majors at their respective colleges."

The USC NAI program tracks the students from sixth grade through the completion of their undergraduate degree (whether they chose to go to USC or not). This tracking includes the majors they chose and how long it took students to complete their undergraduate degree. This data was compiled and subdivided into STEM disciplines to support evidence of the class's impact on the scholars. Since 2013, 42% of USC NAI graduates who have gone to USC have declared a STEM major as freshmen since 2013. Marina V., parent of a student participant named Quetzalli V., stated, "The course nurtured a love of marine life and nature for my daughter. It was an eye-opening experience for her and an opportunity to learn about the human impact on the ocean that really changed her perspective. The course inspired her to major in a STEM field, specifically astronomy." Furthermore, we've also had students choose to become marine biology majors at the university level as a result of the course.

## Conclusion

The marine biology field needs to address its role in the systemically racist policies and barriers that act as gatekeepers and prohibit students of color from participating. Courses like this help to bridge that educational gap and level the playing field. The program offers authentic experiential learning opportunities with scientists and STEM experts and data collection opportunities at a local field site in Southern California. It provides foundational knowledge in scientific research methodologies and is intertwined with science communication and presentation skills, which are exemplified during their research poster symposium.

## Ethics and Consent

Informed consent to participate in NAI and in the NAI Ocean Research Methods Course was signed by parents, guardians, or family advocates.

All of the students photographed in this article had media release forms signed by their parent or guardian and approved the use of the photos for publication.

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## Competing Interests

The author has no competing interests to declare.



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