ELECTRONIC JOURNAL FOR RESEARCH
IN SCIENCE & MATHEMATICS EDUCATION
VOL. 26, NO. 1, 84-101

Attracting Underrepresented Pre-College Students to STEM Disciplines

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ABSTRACT

We present our nascent *STEM Access and Training for Underserved Students* (STATUS), a model to attract Latinx students first to attend college and second to enter the STEM fields. The program consists of a series of hands-on investigative activities in physiology, neuroscience, biophysics, genetics, exercise physiology, biomechanics, environmental science, and psychology aimed primarily at instilling students with a sense of belonging and the excitement of discovery. Each two-hour session consisted of a mini-lecture, familiarization with data acquisition systems, the development of a research question and hypothesis, data collection and analysis, and a brief report. Each week students submitted a reflection on the activities and we used these responses to emphasize self-efficacy. One novel aspect of STATUS is the development of *College Knowledge*, a set of conversational sessions with family members to provide information and resources regarding college admissions, financial aid, campus life, academic requirements, career options, and sources of support. Both students and parents provided enthusiastically positive feedback about their experiences; more importantly, all STATUS participants entered college.

Keywords: pre-college, STEM, preparation, support

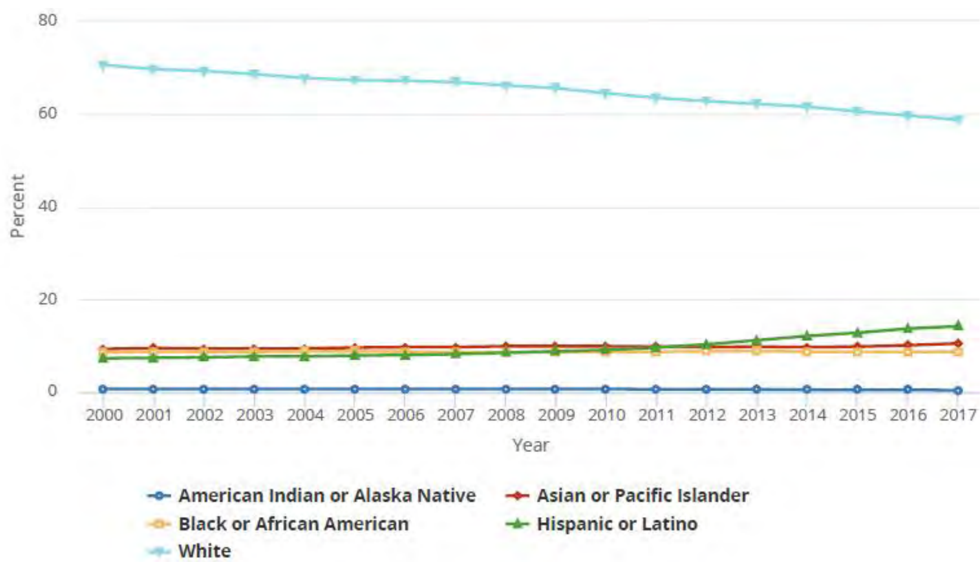
Introduction

There have been numerous efforts dedicated to increasing the number of underrepresented minorities in science, technology, engineering, and mathematics (STEM) fields (i.e., Museus et al., 2011; Contreras, 2011), with emphasis on teacher preparation (i.e., Hayden et al., 2011) or helping aspiring teachers learn about and incorporate culturally relevant experiences in science pedagogy (McCollough, 2020). Others have focused on identifying obstacles to STEM education for underrepresented students through listening to underserved STEM students as to their experiences (i.e., Kricorian et al., 2020), and propose strategies to overcome them (i.e., Flores, 2011). Yet there remains considerable work to be done, particularly in regards to identifying reliable indicators that, once properly mobilized, not only increase enrollment to college, but strengthen persistence of underserved students enrolled in STEM coursework. Further, while much emphasis has been placed on supporting STEM majors in college, less attention is devoted to secondary STEM education. A widely used intervention has involved the development and implementation of pre-college programs designed to engage underserved students early and often; the main idea being that pre-exposure to college-level science content provides a preview of sorts that, in turn, serves to simultaneously de-mystify and encourage students to pursue STEM pathways. However, evidence has shown that often such efforts may produce a somewhat counterintuitive result, inadvertently contributing to a continuing underrepresentation of minority students in STEM fields (data available from National Science Board (2018a).

This, despite the increase in numbers of underrepresented minority students enrolled as full-time undergraduates and the percentage of freshmen declaring their interest in STEM fields; according to the National Science Board (2018b), Science and Engineering Indicators show that in the year 2000, the ratio of white to non-white students (identified as black, Hispanic, Asian or Pacific Islanders, and American Indian or Alaska Native) was 2.70 to 1 (70% white, 25.9% non-white); by 2010 the ratio had decreased to 2.27 to 1 (64.4% white and 28.3% non-white) and by 2018 the ratio was 1.73 to 1 (58.7% white and 33.8% for non-white). See Figure 1 for this information. Furthermore, even though the number of science and engineering degrees awarded each year has been steadily increasing, 398,602 in 2000, 505,435 in 2010, and 684,557 in 2017, (see National Science Board (2019) report Tables S2-6 and S2-7 for the same years 2000 vs. 2017), the percent change for non-white students was minimal (see Figure 2).

Figure 1

Science and Engineering Undergraduate Degrees Awarded from 2000-2017 by Race and Ethnicity

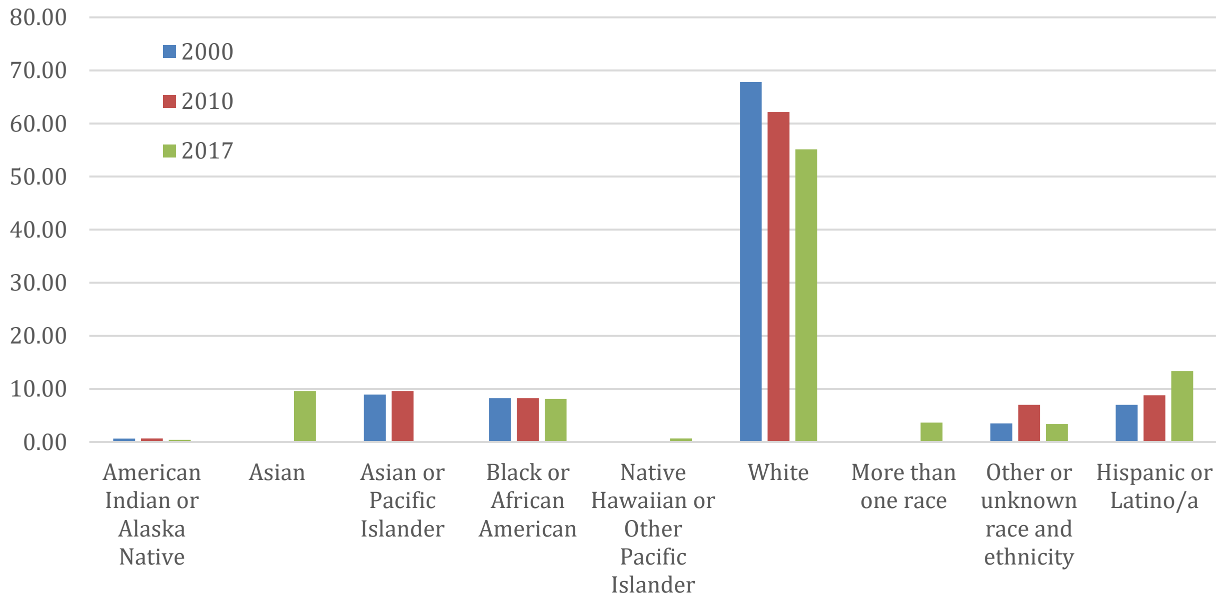


Note: Adapted from National Science Board (2018) report NSB-2019-7.

The percentage of first-year undergraduate students who indicated interest in the STEM fields increased by 9.3% for Asian American/Asian students, 8% for white students, 10.6% for Hispanic/Latinx students, 3.2% for African American/Black students, and decreased slightly by 3.9% for American Indian/Alaska Native students. Yet, according to the same indicators for the same years, no progress was made in increasing the numbers of students who graduated with degrees in STEM areas (Asian Americans/Pacific Islanders increased from 9.3% to 9.8%, African American/Blacks increased from 8.6% to 8.9%, Hispanics/Latinx increased from 7.3% to 11.2%, American Indian/Alaska Natives decreased from 0.7% to 0.6%, and Whites decreased from 70.5% to 62.1%. Summary data is presented in Figure 3. Despite the undeniable progress underrepresented minorities have made in obtaining doctorate degrees over the same period (African American/Blacks: 763 in 2000 and 1434 in 2013; Hispanics/Latinx 735 in 2000 and 1569 in 2013; and American Indian/Alaska Natives: 78 in 2000 and 114 in 2013), these numbers and a multitude of reports bring attention to the needs of our nation in terms of national security, industry, and social programs. At the same time these figures highlight issues such as the recent controversy over high-tech workers and the demand for H1-B visas (e.g., Saltzman et al., 2013).

Figure 2

Science and Engineering Undergraduate Degrees Awarded from 2000-2017 by Race and Ethnicity, as a Percentage of All Science and Engineering Degrees Awarded

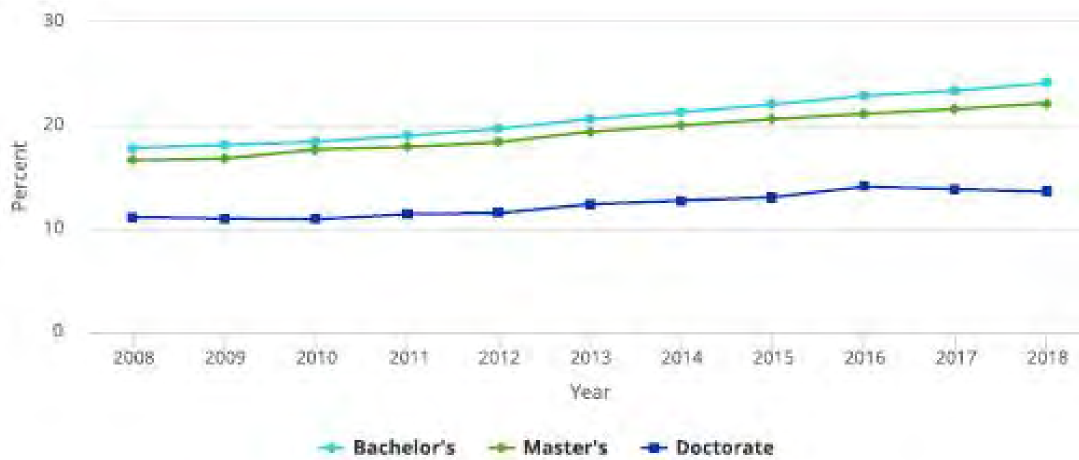


Note: Adapted from National Science Board (2018b) report NSB-2019-7.

A more focused view of this issue reveals further disparities as pertaining to Hispanic/Latinx students. According to the Pew Hispanic Center's 2009 National Survey of Latinos (Pew Research Center, 2013), only 11% of Latinos hold a bachelor's degree or higher, and the reasons for the low enrollment in college are telling: more that 70% need to support their families, and under 50% highlight other reasons (i.e., do not need more education, cannot afford school, do not like school, or limited English ability). The most recent data from the U.S. Census in 2009, for those aged 25 or older, also reflect that reality: Hispanics reported the lowest rates of education of all groups, as only 61% had completed high school or higher, and only 13% had received a bachelor's degree. Thus, the data reflect persistent inequality regarding opportunities to engage in STEM careers for underrepresented minorities, and especially so for Hispanic/Latinx origin (see for example the work of Sylvia Hurtado at the Higher Education Research Institute (HERI) at UCLA, https://heri.ucla.edu/).

Figure 3

Science and Engineering Degrees Earned by Underrepresented Minorities, as a Percentage of Degree Type.



Note: Adapted from National Science Board (2018) report NSF-21321.

Recent data from the National Center for Higher Education Management Systems (2016) reveal that just 20.5% of 9th graders will complete their degree within six years of entering college. These numbers are startlingly lower in our state, Oregon (16.2%). About half of all students who enter college graduate within six years (55.5%), with Oregon just slightly above the national average (56.5%). Alarming as these numbers may be, the data reflect an even more disturbing picture for underserved populations, where the graduation gap between White and Hispanic students is 12-21% (Brownell & Swaner, 2010). Furthermore, first-generation students often self-report as "considerably overwhelmed," and thus are at particular risk of not finishing their college degree; only about 25% nationally succeed in this goal (Chen, 2005). Finally – and directly relevant to the current report – students from underserved populations who complete an undergraduate education tend *not* to pursue degrees in STEM-based fields (Crisp et al., 2009). Several approaches have been introduced to bridge this gap, including better high school science and math instructors, improved facilities, curricula to help alleviate struggles in introductory STEM courses, introductory college science courses with active learning pedagogies, and the development of strategies to attract low-income and underrepresented minorities to college campuses (such as the National Science Foundation's S-STEM program (2002). More direct interventions targeting underserved students' home and community environments as mechanisms for increasing underserved students' likelihood for success in college are relatively recent (i.e., Institute of Medicine, 2011; Rayle & Chung, 2008). Addressing how students can be successful when in college is one thing (see Kezar & Holcombe, 2017a); getting them ready to enter college and face the rigor of introductory science courses is quite another. The challenge is best described by Armstrong and Zaback (2014) in their report to the Appalachian Regional Commission, when they state that 52.7% of Hispanic students and 63.59% of African American students enter remedial courses (as opposed to 49.93% for White students), but only 28% of Hispanic students complete all required remedial courses, as opposed to 31% for African American students, and 52.4% for White students. Similarly, Jimenez et al. (2016) report remedial education enrollment nationally at 56% for Black students, 45% for Latinx students and 35% for White students. The *Condition of STEM 2016* report (ACT, 2016) is promising in that 49% of all tested students are interested in STEM careers, but that only 13% of Hispanic students, 5% of African Americans, and 32% of White students met the ACT STEM readiness benchmark score. Further highlighting the problem of how unprepared students from our own community are to enter college, Jimenez et al. (2016) list Oregon as a solid third highest in percentage of first-time students who enroll in remedial courses as a fraction of total enrollment at 78%, trailing Florida (93%) and Nevada (85%) but well ahead of the next state (New Mexico at 58%). The picture that emerges clearly is that most of these underprepared students are underrepresented minorities and are not ready to face the demands of college, much more the rigors of training in STEM fields. The negative implications for their chances to complete undergraduate studies (or at all) cannot be overstated. These statistics have alarmed educators and administrators at several institutions, who are earnestly developing programs to address this issue of equality in preparedness (e.g., Purdue University, n.d.).

Are there Solutions?

Several initiatives have been launched to address the underrepresentation of minority students in STEM fields, led by Howard Hughes Medical Institute's initiative on Inclusive Excellence in STEM (HHMI, n.d.) Most of these initiatives have focused on retention and STEM careers for undergraduate students. In a recent report, Kezar and Gehrke (2015) call for the development of *Communities of Transformation* designed to provide comprehensive support for all stakeholders involved in STEM education, which also applies to Latinx students. Most of these initiatives are very recent, and little to no data exist regarding their efficacy. When confronted by these facts, so eloquently articulated by David Asai and Cynthia Bauerle (2016), we were compelled to take action at our institution: What could we do in our own community to better prepare Hispanic/Latinx students for a) attending college, and b) entering STEM fields? While these questions have spurred comprehensive (and successful) efforts at several institutions (i.e., Lieberman, 2016), at the time we found it difficult to identify specific institutional initiatives to help Latinx students enter STEM fields in college. Here we describe our initiative, <u>ST</u>EM <u>A</u>ccess and <u>T</u>raining for <u>U</u>nderserved <u>S</u>tudents (STATUS), a pilot project guided by the Institute of Medicine (2011) report on *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*, and especially their recommendation regarding Access and Motivation for postsecondary education, which is worthy of including without change: "Improve access to all postsecondary education and technical training and increase underrepresented minority student awareness of and motivation for STEM education and careers through improved information, counseling, and outreach" (p. 11).

In addressing the low subscription among underrepresented minorities in STEM fields - and especially so among Latinx students - we were motivated by one fundamental principle; that all students deserve a space to learn about science and explore their individual interests in STEM fields. Thus, ours is defined as a space for learning, not one defined by the physical boundaries of our campus.

Our review of the available literature revealed several factors that contribute to the low numbers of underrepresented minorities in STEM fields, wonderfully and eloquently summarized in the aforementioned Institute of Medicine (2011) report with gender disparities further highlighted in the report by Simard (2009), and issues specifically affecting Latinx students emphasized by Flores (2011) and others. Clearly the "build it and they will come" approach is inadequate, and a different strategy should be implemented, one premised upon actively reaching out to these students and their families. The Institute of Medicine report (2011) was the platform upon which we built our STATUS program, mainly by focusing on the recommendations we could control (i.e., develop summer programs in mathematics, science, and engineering that include or target underrepresented minority high school students, p. 178) and not on factors beyond the scope of this project (i.e., recruitment, preparation, and professional development of well-qualified elementary and secondary education teachers, p. 176). Yet, we encountered a paucity of data on how best to address the factors that contribute to the development of a supportive environment for pre-college students from underrepresented minorities. For example, recent evidence regarding positive outcomes associated with incorporation of science activities with parents (i.e., DeLeon & Westerlund, 2021) was not available when the project was initiated. While not the only factor driving student success, lack of familial support among underserved students has been identified as contributing to decreases in individual motivation and academic performance and poorer retention rates (e.g., Dennis et al., 2005), with many researchers recommending that efforts to better engage these students must first attempt to meet them where they are at, by actively cultivating buy-in from family members, themselves best situated to provide daily support and encouragement (see also Garriott et al., 2014). Since we could not find a specific set of ideas or practices shown to contribute to this goal, we developed a series of topics to be discussed with the parents, and this is our *College Knowledge* program, which we developed to help disarm anxieties among parents of first generation students.

How was STATUS Structured?

We adopted an evidence-based approach to shaping every aspect of our program. Our response to the national call to engage underserved students expressing interest in STEM fields was the creation of a sustainable and easy to implement model program to attract *pre-college,* underrepresented students to STEM fields by creating a more personalized path from high school to college. As Graham et al. (2013) pointed out, the need to cultivate the students' sense of confidence and motivation early in their academic career is paramount if they are to succeed in their efforts at STEM education. Thus, our first objective was that students must feel that they belong in a college setting and that attending college is something they can and should achieve. The second objective was to expose them to student-centered investigative laboratory experiences in STEM fields and impress upon them their capacity for accomplishing college-level science work of high quality.

Supporting Mechanisms

It was clear from the beginning that a successful effort would require resources, though not necessarily extensive ones. On the institutional side, we recruited Latinx undergraduate students who were available to participate in this program to accomplish three main goals: first, they served as mentors and role models to the high school students; they had common experiences and they could communicate in meaningful and authentic ways. Second, they served as tutors during the laboratory activities; that way they served as guides to discovery, not only by their presence, but also through their skills and knowledge. Finally, they served as translators, facilitating in-depth discussions during our semi-structured informational sessions with the parents while the students conducted their experiments.

Recruitment of Pre-College Students

One of the most important elements of STATUS was that students and their families felt welcome to our campus. Every aspect of the process had to be authentic and sincere; after all, providing authentic college-level laboratory experiences in science was the chosen way to enhance the students' confidence and sense of belonging. Our nascent effort required beyond-campus thinking on the part of the authors, especially given the dearth of institutional outreach efforts to underserved high school students interested in the sciences. Following a series of planning meetings with officials from the local school district, we received permission to contact the high schools in our area to recruit qualified and interested underrepresented students for this work.

As far as we were concerned, this was the most important aspect of the entire project. It became very evident that our success was predicated on creating connections with existing mechanisms that support these students to enter college in the first place, and we had to incorporate mechanisms that allowed us to come alongside these students and their families. The school district has created special positions for Community Science Outreach Coordinators (CSOCs), who serve as liaisons between teachers, students and their families, and outreach opportunities for students (i.e., internships). The CSOCs also hail from underserved backgrounds and are committed to helping *all* students succeed in school. Their multiple connections to the local community provide them with instant credibility with students and their families. The critical role school counselors play in underrepresented students entering and succeeding in college has been documented elsewhere (i.e., Cholewa et al., 2018). During our meetings with the CSOCs from each of the local high schools, we received enthusiastic support and helpful suggestions that shaped our program. More importantly, we received their endorsement for this work, and they took it upon themselves to identify students who should participate in STATUS; these students had expressed interest in science and most were interested in attending college, although none had any information about options for post-secondary education. We selected second- and third-year high school students (rising juniors and seniors), with an eye towards their remaining high school education serving as a stepping stone for college admission. We generated informational material in two languages (English and Spanish), and the CSOCs distributed them to the students. Within a short time (less than two weeks) we had reached the maximum number of students (twenty) our program could accommodate, since laboratory space is limited. Two more students were added as younger siblings of students initially selected (one rising junior and one rising sophomore) for a total of N=14 female students and N=8 male student participants. In addition, the CSOCs volunteered to serve as interpreters for our introductory gathering with students and their families. Following suggested best practices, we planned this meeting as an informal greeting session accompanied by food for all students and their families, with a menu recommended by the CSOCs. At this informal gathering, we were careful to introduce ourselves on a first name basis, always with a native speaker at our side, as we explained the objectives and design of STATUS. We answered questions and worked with the families on scheduling of events, parking passes for those who drove, vouchers for those who relied upon public transportation, and directions to the various buildings on campus where the activities would be held each week. We were careful to schedule all meetings during the late afternoon hours when the parents would be done with work and had adequate time to visit the campus. We encouraged both parents to attend and bring along any siblings. Each week we provided ample snacks for all (fresh fruits, juice, and cookies) and access to nearby computers (under supervision) to help younger children remain happy and engaged, freeing their guardians to participate in the parent informational sessions.

STEM Curriculum

We developed partnerships with faculty from diverse STEM fields (Psychology, Genetics, Biophysics, Exercise and Health Science, Neuroscience) who created a series of interdisciplinary, STEM-related modules designed to make science approachable, enjoyable, and interesting to these students. Since STATUS was intended as an incubator for students to pursue STEM disciplines in college, the emphasis on teamwork, the appreciation of the importance of the practical skills gained, and the realization of their potential for a successful college career are among the crucial outcomes for this group of pre-college students. We note that, in our approach, these disciplinary activities were considered little more than a tool for reaching these young people, aiming to offer a variety of experiences and opportunities for hands-on learning.

In our STATUS model, underrepresented students attended a series of investigative laboratory workshops once per week for at least six weeks throughout the early summer (immediately after the end of the school year), designed to expose them to theoretical and methodological questions in each STEM area. Each STEM module also included training in the use of data acquisition systems, and education on topics such as experimental design, data collection and analysis, and presentation of results. Each module was taught in English by a faculty member actively engaged in research on the topic, and students were provided with guided activities to answer their "research" question. Every week students were introduced to a lesson plan that included a brief theoretical justification, description of procedures, and a brief assessment designed to help students reflect on what and how they learned. See Table 1 for details on this and other interdisciplinary, STEM-related modules.

The grip strength experiment was the first in the sequence, and students were asked to consider a relatively accessible question: whether their dominant hand was stronger than their non-dominant hand. They were encouraged to offer an initial response, and the dominant hand was invariably considered to be stronger. When asked to explain why they think this is the case, students usually cited evidence that they use the dominant hand to write, hold a utensil while eating, or in handling their cell phone. The instructor then challenged the students with an analogy to help them consider these responses: would mere walking make one a better runner? The obvious negative answer to that question helped students consider whether the stimuli they described were sufficient to cause the dominant hand to become stronger or just more agile. This served as a reminder that in science, obvious answers are not always accepted as correct until they are supported by data/evidence. Students were then asked to think of ways to actually test whether one hand is stronger than the other, and they offered ideas such as bench pressing, or lifting weights with one hand or the other, or whether batting a ball with one hand or the other is evidence of greater strength, ideas that were praised by the instructor as excellent starting points for inquiry. Soon however, the students identified that such approaches did not actually answer the research question: which *hand* was stronger? They were encouraged to use lab computers and identify examples of hand strength measurement and quickly settled on a grip strength test as the preferred experimental technique. The instructor then guided student thinking towards articulation of a formal research question (*Which hand is stronger?*) and a testable research hypothesis (*The dominant hand is stronger than the non-dominant hand*) on the whiteboard agreed upon by the students prior to data collection.

The instructor guided the students through a grip strength data collection and analysis session using the Biopac™ data collection systems, simultaneously emphasizing that these are the same systems used by college students enrolled in Human Physiology courses. The instructor placed particular emphasis on proper experimental protocols and avoiding data collection errors (e.g., students laughing or looking at the screen during the experiment, since such actions could alter the results). Students then calculated grip strength and wrote the results for the dominant and non-dominant hand side by side on the whiteboard. A simple review (no statistical analyses used in this module) revealed that not all participants exhibited greater strength using their non-dominant hand, thus the research hypothesis had to be rejected. Having gained a basic understanding of the data collection and analysis process, students were encouraged to work in groups and design experiments of their own using the Biopac™ devices; some examples include testing strength using the thumb opposed by each finger (one at a time), muscle fatigue by exerting maximal strength until force declined by approximately 50%, and whether keeping an arm extended or bent at the elbow makes a difference in maximal force exerted. The next step in this activity was that each group gave brief informal presentations/demonstrations to the others, and answered questions about their research question and the methodology or their findings. Finally, they invited their parents to become participants in their experiment and share the experience.

Table 1

Science Modules Developed by College Faculty.

Lab Title	Description
Grip Strength	Students learned about the use of data collection instruments to answer research questions (i.e. differences in maximum grip strength between the dominant and non-dominant hand); they are also exposed to the fundamentals of scientific hypothesis testing and the role of statistics.
Earthworm nerve conduction	This lab focused on the study of action potentials as drivers of all thought and movement. This activity placed emphasis on experimental setup and potential for errors in measurement.
Balance	A comparison between different instruments that measure the same variable (balance) provided an opportunity for students to understand the concepts of reliability, validity, and accuracy in measurement. Students also considered the application of such tests for people with mobility difficulties or the aging population.
The teenage brain	In this module, instructors introduced the idea of the teenage brain, focusing on risky behavior and driving. Students had a hands-on opportunity to engage with a research study on peer influences on teenage risk taking and discuss the findings and implications of research in this area.
Blood pressure and ECG	In addition to performing these measurements in the lab, students used the blood pressure cuffs at home to practice on relatives and friends at different times of the day. The importance of these simple measurements for health and disease was also discussed from an epidemiological perspective.
Sheep brain dissection	Students used a sheep brain dissection as an entry point for discussing neural changes during development, with an emphasis on asynchronous brain development during the teenage years, which can help explain risky behavior during adolescence. Students had a hands-on opportunity to dissect a sheep brain to introduce basic brain anatomy. Students then learned about non-invasive neuroimaging methods and discussed the findings from neuroimaging research on the teen brain.
Lie detector testing	A more playful activity where students designed a set of questions for a lie detector test using research-grade data collection systems. The emphasis was on identifying events through multiple physiological variables to identify truthfulness of responses. The potential for error and applicability (i.e., in a court of law) were discussed.
Microscope construction	Students examined the structure/function relationship of items they collected around campus using an inexpensive portable microscope (https://www.foldscope.com/) and taking pictures using their cell phones. The emphasis is on the physics of optics and the engineering aspects of the microscope along with generating excitement for students to collect and analyze their own samples.
Vision	This lab helps students understand the structure and function of the eye and the neural processes involved in vision. Cow eye dissections and a series of visual tests helped students understand this sensory mechanism and identify how problems with vision can be corrected.

Note: Each student participated in at least six activities, each designed with a set of specific science objectives in mind. All lesson plans were designed for novice student participants.

All STATUS modules followed a similar pattern of first establishing a basic theoretical framework and relevance for the work, followed by hands-on activities, and critical evaluation of evidence, all the while providing students with the freedom to experiment on their own and gain the confidence needed to consider a STEM education in college.

College Knowledge: Parent Information Sessions

Our review of the literature helped us realize very quickly that in this population of underserved students, critical decisions such as attending college are made by the entire family in ways that consider the best interests of the entire family. Accordingly, if we were to succeed in this effort of encouraging students to a) enter college, and b) enter STEM fields while in college, it was imperative that we also involve the students' families. That way they too could join any session if they wanted, contribute to the work of these students, and encourage them in their efforts. In the absence of a set of best practices to follow, we were guided by our desire to provide support for parents so they could navigate the college landscape: how could they help select the right school for their student, apply for admission, enroll in classes, examine financial aid models, negotiate housing options, and navigate academic advising and resources, campus life, extracurricular activities, and so on. According to a report by the Get Schooled Foundation (2013), these topics represent uncharted territory for many parents of first generation students, especially those from underserved populations. Several resources (e.g., Ajinkya et al., 2016.; Berumen et al., 2015) helped shape the information and material we provided to the parents.

In planning this comprehensive set of informal information sessions with parents (with the help of current students who were native speakers that relayed their own experiences) we aimed to help the parents become more knowledgeable, and thus more effective, in their support of their student. As Dennis et al. (2005) demonstrated, this support is of paramount significance, as lack of family support negatively affected college outcomes such as GPA, adjustment and commitment, even if family expectations were not valued as significant in a population of Latinx students. The study provided evidence of the important role families play in helping prospective students develop intrinsic motivation for attending and succeeding in college. While studies have highlighted the important role integration and a sense of belonging play in the success of underrepresented students in college (i.e., Wadenya & Lopez, 2008), little evidence exists regarding the steps a family can take to prepare their college-bound student. We prepared for the *College Knowledge* work by relying on material and ideas from the earlier contribution by Tierney and Auerbach (2004), and the suggestions by Moore (2006), as positive steps towards a successful strategy to recruit students from underserved populations.

Project Assessment

Best practices in science pedagogy require comprehensive, IRB-approved assessment plans; for this project we used a mixed-methods design. We developed a series of surveys for students: 1) focusing on metacognition, after each of the modules we asked them to reflect on the main ideas and methods used, and to draw reasonable conclusions from the data they collected. These reflections helped students internalize the specific learning objectives and guided faculty to refine their lesson plans for future iterations of the program. 2) Before and after the sequence of lessons, we administered a self-efficacy survey to gauge gain in students' confidence in engaging with science work. This survey employed a 5-point Likert scale (1: Not at all confident, 5: Totally confident) and was adapted from the biology self-efficacy scale developed by Baldwin et al. (1999). 3) At the end of the period we asked students to submit (anonymously if they chose to do so) a one-page reflection on their experience participating in the STATUS program. We used these comments in a qualitative analysis of student attitudes about STATUS. We emphasize here that while these data are not offered as evidence of comprehensive evaluation of the goals we established for our program, they proved beneficial to helping us frame suggestions for future adaptations of STATUS for use by others.

Outcomes

In terms of participation and interest, the STATUS program was a success. For our pilot effort we recruited 20 students and added two more at the request of family members. These students attended all weekly sessions, although regretfully only 15 students were able to participate in the last meeting, where the students and their families attended a BBQ where we celebrated their accomplishments with a certificate and the awarding of an iPad tablet to one student via random drawing.

At the end of the program we evaluated the success of the first goal of STATUS (students must feel that they belong in a college setting and that attending college is something they can and should achieve) by asking students to comment on their views regarding the program in a personal reflection, a format they were familiar with through their weekly work. Student responses to this reflection were very complimentary and can be grouped in four general categories:

A. Students gained enjoyment from their participation in this program
   - "I learned so much and I'm glad I was part of this amazing learning opportunity."
   - "Being able to participate in STATUS was an amazing experience."
   - "At the end of the day I am glad I was able to be part of this program and I really enjoyed every piece of it."
   - "I was surprised that I really got in to this. I am thankful to be in that class of science."
   - "This experience made me a better person and have a better thought about science and I really hope I get to experience this again sometime."
   - "My overall experience with STATUS has been great. I was able to learn new things and also things that would be of benefit for me later on in my future."

B. The program offered opportunities for training and careers in STEM
   - "Every class created an even bigger desire for me to work in the medical/health field."
   - "This program helped me confirm that I do want to be in the health field."
   - "I learned a lot and made me more interested in science. I would like to have science as an elective in high school now because of this… This science program helped my interest in science a lot."
   - "Being in the STATUS program made me realize that there are some careers that could be really fun, for example when we had the blood pressure activity… the students were able to experience what a nurse or any medical field requires."
   - "My overall experience during the program excited me to continue following my dream in getting in the medical field."
   - "it was very interesting being able to contribute in experiments that were able to show us what the type of things you do when [sic] your in a science/health career."
   - "Participating in the STATUS session helped me realize how much I am interested in entering into a career that involves science."

C. Students enjoyed specific lessons
   - "I mostly enjoyed the class session on blood pressure, considering the fact that I want to study to be a cardiac sonographer…"
   - "My favorite lab was brain dissection…"

- "In my opinion I find the function of the eye really interesting and would like to learn about it more."
- "Being able to learn how to take blood [sic] preasure was really interesting…"
- 'My favorite activity during the program was dissecting the sheep brain. It was cool how we were able to see how a brain functions and name the different parts of the brain."

D. Students experience science teaching in a college environment
- "Having those lessons was very helpful because it gave me an idea of how lectures are in college and it prepared us for the future."
- "My participation in the STATUS program has been very beneficial to my long-term plans in terms of attending a college or university."
- "I find it extremely grateful that professors from Willamette took time to teach us different areas in science. Thank you all so much for your time!"
- "This benefits me/will benefit me in the future because I wanted to learn more about [sic] spychology, and with the last lab I have learned that [sic] spychology isn't really my thing, although everything was interesting and fun."

Such comments reveal the students' appreciation for having this opportunity and that they are making meaningful connections between the STATUS activities and future aspirations.

For the second goal of STATUS (impress on students that they are capable of accomplishing college-level science work of high quality) we assessed the success of our pilot project using a pre/post self-efficacy survey which the students completed anonymously using a unique alphanumeric code for matching. The results of the analysis are presented in Table 2.

These data are presented not as unequivocal proof of the success of STATUS, but as cautious evidence that students' STEM self-efficacy increased over the course of this summer science program. Taken together, the student responses indicate appreciation for the opportunity to participate in a college-level STEM experience, and confidence in their ability to succeed in a STEM field in the future. The parents of the students were very complimentary of the informational sessions we provided, especially the discussions regarding the admission and financial aid procedures, and campus life opportunities. Their responses to a separate qualitative survey indicate their appreciation for their children having the opportunity to visit the university and engage in college-level laboratory activities. Above all, they expressed their strong commitment to supporting their children entering college and following STEM careers; of particular interest was their conviction that their children would enter STEM fields with their compass pointing towards ways to benefit others. We are pleased to report that all the students in our project have entered college and are pursuing STEM fields of study.

Conclusion

Our response to the national call for increased participation of underrepresented minorities in STEM fields was the creation of STATUS, a summer program with hands-on, authentic laboratory experiences in a variety of scientific fields. We present our STATUS model in hopes that others will identify the same need and potential for creating opportunities for underrepresented students to engage in STEM fields. Our nascent, bottom-up approach was founded on a spirit of inclusivity and every aspect of this work benefited from the available literature. The lab curriculum reflected college-level activities and learning objectives; as Jimenez et al. (2016) recommended, setting high expectations and helping students meet that standard is essential for their success in post-secondary education. The success of this undertaking mirrors outcomes reported by the University of Massachusetts Donahue Institute (2011) report and others (see examples at https://www.edexcelencia.org/programs-latino-student-success), and strategies employed by other successful programs (see Foltz et al., 2014). It was imperative that students experienced science in a college setting; only then would they have an increased sense of belonging in a college science field. In providing active learning opportunities we followed current standards in science education (e.g., Wieman, 2007); our approach was recently found to be especially beneficial at closing the STEM achievement gap for students from underrepresented minorities (Theobalt et al., 2020).

The success of STATUS cannot be attributed to any single factor of the program; by employing the framework model described by Dennis et al. (2005), we offered a comprehensive approach to introduce students from underrepresented populations to a college-level STEM environment. Our findings support the recommendations put forth by Kezar and Holcombe (2017b) and reflect the holistic model described by Moore (2006) regarding male African American students' persistence in engineering, namely the important role played by parents, teachers, and school counselors (Lichtenberger & George-Jackson, 2013).

This project was transformative for the instructors who had to adjust lesson plans and tailor them for the high school students. College faculty had to use appropriate language, customize the work to match the students' skill level, and learning objectives had to be reasonable and reachable. We benefited from our interactions with the students and their families who appreciated our genuine interest and care, which was also highlighted through our interactions with the CSOCs prior to the start of the program. Our willingness to listen and accept the CSOCs' suggestions, down to the menu for the initial informational meeting was a catalyst for open discussions with parents during the *College Knowledge* sessions. It is thanks to their advice that we planned to provide snacks for the whole family and child care during the sessions, so the entire family could attend. For anyone who plans such science outreach activities with Hispanic/Latinx students in the future, we strongly recommend developing a welcoming environment for the entire family; the setup allowed parents to observe their children engaging in scientific investigations and allowed the students to share their excitement with their parents. As discussed earlier, this is a central element of the social support necessary for the success of these students in college. Finally, the high school students really appreciated the presence of college students who served as mentors and role models; they answered questions, offered advice and encouragement, and served as ambassadors for the institution to this group of participants and their families. The modest stipend we could offer did not adequately reflect their enthusiasm, positive attitude, and many contributions to the success of STATUS.

We note that this effort was successful, despite such outreach efforts not being part of our institution's mission statement or our strategic vision, thus limiting institutional support. We are exploring ways to expand STATUS within our institution and our community first in line with the recommendations put forth by Holcombe and Kezar (2019), recommendations for institutional changes and further research by Crisp and Nora (2012), among others, and resources such as those available by the Center for Urban Education (2016; see https://cue.usc.edu/tools/stem/). Finally, we stand prepared to provide support (material, laboratory activities, and assessments) to anyone who plans to initiate a pre-college STEM outreach program.

Table 2

Student Responses to the Self-Efficacy Questionnaire

Question STEM: How confident are you that…	PRE M±SD	POST M±SD	t-value * (p<0.05) ** (p<0.01)
after reading an article about a science experiment, you could write a summary of its main points?	3.07±0.88	3.93±0.70	**
you could evaluate a science class lab report written by another student?	2.93±1.28	4.00±0.65	**
you could write an introduction to a science class lab report?	2.80±0.67	4.07±0.70	**
after reading an article about a science experiment, you could explain its main ideas to another person?	3.13±1.06	4.13±0.74	**
you could read the procedures for an experiment and feel sure about conducting the experiment on your own?	3.53±0.74	4.07±0.59	**
you could write the method section of a science class lab report (i.e., describe the experimental procedures)?	3.20±0.94	3.93±0.59	**
after watching a television documentary dealing with some aspect of science, you could write a summary of its main points?	3.60±0.73	4.00±0.75	0.069
you can be successful in a science course?	3.87±0.91	4.47±0.74	*
you could write up the results to a science class lab report?	3.33±0.97	4.13±0.74	**
after watching a television documentary dealing with some aspect of science, you could explain its main ideas to another person?	3.33±1.11	4.27±0.79	**
you will be successful in a science course?	3.60±0.91	4.40±0.82	*
you could write the conclusion to a science class lab report?	3.20±0.67	4.27±0.59	**
after listening to a public lecture regarding some science topic, you could write a summary of its main points?	2.93±0.70	4.00±0.65	**
you would be successful in a college biology course?	3.13±0.83	4.40±0.63	**
you could analyze a set of data (i.e., look at the relationships between variables)?	3.33±0.61	4.07±0.59	**
after listening to a public lecture regarding some science topic, you could explain its main ideas to another person?	2.87±0.91	4.40±0.73	**
you would be successful in a college chemistry course?	2.87±0.83	4.13±0.35	**
you could tutor another student on how to write a lab report?	2.33±0.97	3.73±0.59	**
you could critique an experiment described in a science textbook (i.e., list the strengths and weaknesses)?	2.93±0.88	3.87±0.99	*
you could tutor another student in a science course?	2.40±0.98	3.87±0.91	**
you could ask a meaningful question that could be answered experimentally?	2.87±0.83	4.27±0.70	**
you could explain something that you learned in this program to another person?	3.80±0.94	4.73±0.59	**
you could use a scientific approach to solve a problem at home?	3.00±0.75	4.53±0.74	**

Acknowledgments

This project was completed with generous support from the W. M. Keck Foundation. The authors also wish to express their gratitude to Mrs. Melissa Reynaga, Mrs. Liza Rodriguez, and Mrs. Jacqueline Benavides for their support and encouragement. We are also grateful to the students who participated in this program and their parents, who helped us develop STATUS into a complete science outreach program for pre-college students.

This work was supported by the W.M. Keck Foundation.

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