



Figure 1. Logic Model: academic success of STEM Center students

or “inputs” that the campus has committed to activities, to the actual program activities and results from those activities. The results are separated between outputs, such as counting the number of student hours of tutoring and student learning outcomes – what content knowledge was actually learned and retained by the student because they worked with a tutor.

For outputs the guiding question is: Did the right people participate in the right numbers?

For outcomes the guiding question is: Did participants demonstrably learn what was intended?

Lastly, the impact is how this one set of small activities might contribute (but is not solely responsible) for larger campus measures such as retention and graduate rates and appropriate time to graduate.

Our unique approach is to place the assessment cycle on top of the outputs and outcomes. Student learning assessment has its own methodology, where we look at outputs and outcomes simultaneously. Such technique connects the logic model approach from the nonprofit section to how we think about student learning achievements in the aggregate in higher education as assessment tracks learning as a developmental process but provides us with a continuous self-reflexive basis for improvement. The following is using the STEM Center as an example of this type of results-driven look at student learning in higher education.

4. Outcomes and impact on student participants

4.1. Academic support for undergraduate students

One of the main STEM Center goals is to provide academic support for undergraduate student for math, science and engineering courses in order to contribute to increasing UC Merced retention rates in the STEM disciplines. The STEM Center provides a location for a learning community of students to gather and collaborate on schoolwork and projects. Since its opening in Fall 2013, the center observes that the amount of student using the room steadily increases by an average of nine percent per semester. Currently, we serve about 310 individual students who use the location on regular basis throughout the semester. Of these students, typically, 65 percent are math and science majors, 30 percent are engineering majors, and 5 percent are non-STEM majors.

The STEM Center's Peer-Tutor/Mentor Program supports student learning and provides peer-tutoring assistance for math, science and engineering classes. Peer-tutors/mentors are selected based of their exceptional academic achievements, robust work ethics and excellent communication skills. These students have a strong dedication to the STEM Center's mission of aiding the UC Merced undergraduate community and serve as role models for their peers. Peer-tutors/mentors volunteer their time, unless a grant funding is obtained to provide stipends. An average of twenty students per semester provide 35 hours of tutoring per week for a range of math, chemistry, physics, biology, engineering, and computer science courses. A desired outcome is observed every semester, where above 80 percent of students using our services self-report that they are satisfied or highly satisfied with quality of tutoring and the use of the STEM Center.

In an effort to assess the STEM Center's contributions to the retention rates in the STEM disciplines, we evaluated the academic performance of students who regularly attended (around eight or more visits per semester) the STEM Center. With the assistance of the SNS Assessment Manager, the STEM Center administered surveys and further analyzed the survey data. We understand that our analysis has limitations, a major one being our small sample of students coming from various STEM majors and class levels, which makes establishing a control group very challenging. In order to create a more focused data analysis, we looked at final grade data sets for chemistry courses. Chemistry is one of the subjects most studied for at the STEM Center, therefore the General Chemistry I final grades were analyzed for Fall 2015 semester. Grades of students

who received STEM Center services were compared to the rest of the students in this Chemistry course. The Wilcoxon-Mann-Whitney test suggests that there is a statistically significant different between the distributions of grades of students who went to the STEM Center and those who did not ($z = 2.403$, $p = 0.0162$).

Highly satisfactory service outcomes are also observed in respect to the overall Grade Point Average (GPA) for a selected group of students participating in the National Science Foundation (NSF) funded Math and Physical Sciences Program (MAPS) led by the STEM Center. In the span of six years, 90 percent (50 students) of MAPS scholars successfully completed the program. MAPS scholars continuously demonstrated better academic standing (GPA 3.1 vs. 2.6 out of a total of 4.0 GPA) and higher retention rates (82% vs. 67%) compared to the control group consisting of students with similar backgrounds not enrolled in the program.

Another important outcome of the STEM Center's goals is related to the peer-tutors/mentors professional development. While serving their peers, our tutors/mentors gain work experience, further understand the dynamic of STEM academic communities and develop further develop their teamwork, leadership and communication skills. With the purpose of increasing their understanding of diversity sensitivity in academia and best practices and behaviors in working with peers, the STEM Center offers the Peer-Tutors/Mentors Professional Development Workshop Series. Assessment in this area demonstrates very desirable outcomes. The 2018-19 Survey results show that 100 percent (16 students) of peer-tutors/mentors agree that their skills in working with a diverse group of peers increased, with 63 percent self-reporting "much stronger" and 37 percent reporting a "stronger" increase. All students also self-reported growth in communication abilities, with 70 percent "much stronger" and 30 percent "stronger."

4.2. Undergraduate research and fellowship opportunities

A major goal of the STEM Center is to introduce undergraduate students to the importance of undergraduate research and to specific fellowship opportunities. The STEM Center uses presentations, one-on-one consultations, and support for UC Merced fellowship programs to help students understand the significance of strong academics and undergraduate research involvement, and to obtain scholarships, fellowships and internship positions. The majority of the students who visit the STEM Center require assistance to uncover research opportunities they might get involved into. As an outcome, 100 percent of the students self-report that they understand what options are available for them

and an average of 80 percent of them uncover research opportunities that meet their specific interest. Additionally, individual consultations help students navigate the process and prepare a successful application. As a result, up-to-date, an average of 50 percent (280/560) students were placed in fellowship programs at UC Merced or obtained summer research positions in academia (among them, UC Berkeley, UC Los Angeles, UC Santa Barbara, UC San Diego, Harvard) or National Labs (Lawrence Livermore, Sandia). It is important to note that in assisting students to obtain an undergraduate research position, selection bias is a limitation to the data. Each student is evaluated based on their academic progress and conceptual knowledge, which are required to prepare a competitive application. In some cases, the STEM Center staff works with students to draft a plan for improving academic performance before moving on to securing a research position.

Via collaborative work with faculty and administrators, the STEM Center supports UC Merced federally-funded Undergraduate Fellowship Programs. The Center for Cellular and Biomolecular Machines (CCBM) was established in Summer 2016 with the National Science Foundation (NSF) support and focuses on multidisciplinary research in the areas of physics, chemistry, biology, material science, and bioengineering. CCBM's Scholars Undergraduate Research Fellowship is a part of the center and provides research and professional development experiences to eligible UC Merced and off-campus students. A total of 43 UC Merced students participated in the CREST Scholarship Program in the span of three academic years. The summer component of the fellowship supported a total of 29 students visiting from colleges such as Merced College, CSU Stanislaus, UC Irvine, and University of Florida.

The Merced nAnomaterials Center for Energy and Sensing (MACES) was launched in Summer 2015 with the support from the National Aeronautics and Space Administration (NASA), as a research and education center, focused on energy and sensing for space applications. As a part of MACES education activities, the Undergraduate Research Fellowship Program was established to provide training and professional development opportunities for students, specifically aiming at groups traditionally underrepresented in the STEM field. In order to enhance students' conceptual and interdisciplinary knowledge, the program integrates research experience, mentoring and workshops on topics ranging from presentation skills to career preparation. The program offers opportunities not only to UC Merced students, but also to those in local community colleges and in the nearby campuses of the California State University (CSU) system. In the span of four years, a total of 75 UC

Merced and 25 non –UC Merced students participated in the program; more than half of these students were from underrepresented groups. The program is evaluated yearly and data typically demonstrates 100 percent overall satisfaction [13]. Figure 2 represents findings for the Summer 2018 student cohort of students (N = 7). Students report that MACES program enhanced their learning and intellectual development. All students agree that MACES increased their STEM knowledge and, an average, 86 percent of the students agree that MACES increased their confidence and STEM-related abilities [14].

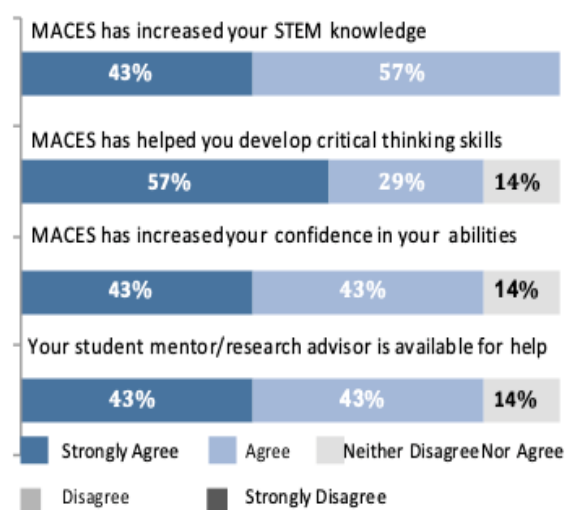


Figure 2. MACES’s impact on students’ intellectual development and STEM knowledge

4.3. K – 12 STEM Outreach

The STEM Resource Center is committed to building a strong connection with the wider Central Valley communities, such as higher education institutions, local schools and organizations interested in the STEM field. Successful partnerships led to the implementation of a broad range of STEM demonstrations and hands on activities, mainly targeting K - 12 schools. Since Fall 2014, the STEM Resource Center participated in the design and implementation of seven major K-12 outreach initiatives: three offered to high school audience (MACES Outreach Program; CCBM - Science and Technology Enrichment Program, GirlCode Workshop), three offered to elementary/middle school students (Young Engineer and Scientist Academy, Mother-Daughter Science Camp, SWEET Academy) and one targeting 6-12 grade students (Expanding Your Horizon Conference). Led by STEM Center’s staff, UC Merced undergraduate and graduate students were present at four high schools and seven elementary/K-8 schools in Merced,

Madera and Fresno Counties. During these visits, we reached out to 1150 high school and 790 elementary/middle schools students. For all on- and off-campus events, University of California policy for working with minors is followed and UC Merced students volunteering at each event are instructed on the administrative and ethical aspects of such work. The STEM Center's assessment goal here was to have 80 percent of the K - 12 students self-report being satisfied with the activity they participate in. Results demonstrate that this benchmark is surpassed, with above 90 percent of the students reporting such satisfaction. Additionally, results show that STEM Center-led outreach activities increase K -12 students' knowledge and interest in the STEM field. For example, a survey administered to 40 high school students attending a MACES-led trip to NASA Ames Research Center shows that attending the trip significantly increased student's interest in STEM and NASA careers [15]. Of all attendees, 82 percent report increased interest in a career in the STEM field and 83 percent report increased interest in NASA careers (Figure 3).

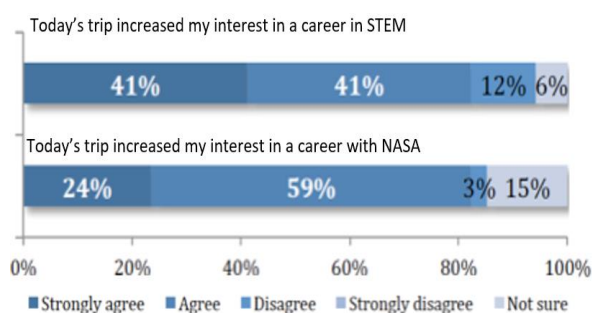


Figure 3. High school students: increasing interest in STEM and NASA careers

4.4. Grants and external funding opportunities

The STEM Center demonstrates excellent performance related to obtaining external funding with the purpose of increasing peer academic support and provide research fellowships for undergraduate students. Since Fall 2014, the STEM Center led the submission of proposals or provided extensive support to faculty on grant writing. As a result, it contributed to obtaining five successful grants, through which it supported peer-tutor payment and professional development, student-worker salaries, and undergraduate research fellowships. In the span of four years, from AY 2015-16 to AY 2018-19, the STEM Resource Center contributed to bringing a total of \$1,131,000 in external finding from funding resources such as NASA, the National Science Foundation, and UC Office of the President. Of them, approximately \$31,000 were used for peer-

tutors/mentors hire, \$2,000 were used for student-workers hire, and \$1,098,000 were distributed as undergraduate fellowships. Overall, the external funding aided the STEM Center to increase its number of peer-tutor/mentor hours, provide trainings for peer-tutors/mentors and place a larger number of undergraduate students at research labs.

5. Conclusion

In conclusion, our work demonstrates that well-structured academic and extra-curricular support contributes to students' conceptual learning and enhances undergraduate research and professional development experiences. Combining our assessment plan with a logic model improved our continuous improvement processes and helped us create a strategic evaluation of the STEM Center. Via carefully planned efforts in providing peer-tutoring/mentoring assistance and undergraduate research support to UC Merced and programs and individual students, the STEM Center impacts their success and helps them achieve meaningful results. Leading K-12 outreach initiatives contributes to building a strong connection between UC Merced and the wider California Central Valley communities and ultimately contributes to college acceptance, retention and graduation.

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