

**An example of *intentionality*  
within a research center at a research-intensive university**

The Simon A. Levin Mathematical, Computational and Modeling Sciences Center (SAL-MCMSC, or Levin Center<sup>1</sup>) was founded in 2008 at Arizona State University by Dr. Carlos Castillo-Chavez. The Center takes a multipronged approach to create a dynamic community of quantitative scientists and mathematicians, driven to contribute to the solution of problems in the biological, environmental, and social sciences. Through flexible research and cross-disciplinary programs, the Levin Center trains a new generation of scientists whose research is driven by “solution” rather than “discipline.” Armed with this mindset, the Center will promote, support and encourage teams and faculty that do not hold an exclusive reductionist view of the world but that are willing to look at problems from a holistic or systems perspective.

In addition to its overarching research activities, the Center houses and supports a doctoral program, a summer research experience for undergraduates, a summer residential program for first-generation college-bound economically disadvantaged high school students, and most recently has founded a consortium of universities in Latin America to increase international exposure and cultural diversity among Center students, faculty and staff.

This unique approach is taken with deliberate steps to create a tailored program that will create cultural competence and awareness to move students toward higher levels of achievement and self-confidence, thereby:

- increasing minority representation in the STEM fields;
- providing access and opportunities for students to conduct research working in scientifically and socially relevant problems with top-notch faculty from around the country and the globe;
- developing a domestic pool of talented individuals to strengthen our nation’s STEM talent pool, enhancing our national security and global competitiveness.

These activities directly support the goals outlined in ASU’s mission, vision, and values:

*ASU is a comprehensive public research university, measured not by whom it excludes, but by whom it includes and how they succeed; advancing research and discovery of public value; and assuming fundamental responsibility for the economic, social, cultural and overall health of the communities it serves.*

Key programs moving the center forward in these efforts include: the Mathematical and Theoretical Biology Institute (MTBI), The Joaquin Bustoz Math-Science Honors Program (JBMSHP), The Strengthening the Understanding of Mathematics and Sciences (SUMS) Institute, the Latin American Consortium on Environment - mathematics, biology & engineering (LACEmbe), the Applied Mathematics in the Life and Social Sciences (AMLSS) doctoral program,

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<sup>1</sup> <https://mcmcs.asu.edu/>

and key sponsored projects such as the LSAMP Bridge to the Doctorate and NSF's International Research Experience for Students.

### **Mathematical and Theoretical Biology Institute (MTBI)**

Established in 1996 at Cornell University, the Mathematical and Theoretical Biology Institute<sup>2</sup> moved to Arizona State University in the spring of 2004. From 1996 through its 2018 summer program, MTBI has recruited and enrolled a total of 507 regular first-time undergraduate students and 78 advanced (returning) students. Of these regular students 420 are U.S. citizens or permanent residents; 290 (69%) are underrepresented minorities and/or members of the Sloan Pipeline Program (URMs include Hispanic, African- American and Native American students) who have been provided mentoring, and many of these teaching and graduate assistants returned to MTBI for multiple years. Through July 2017, 281 out of 420 (67%) of U.S. MTBI student participants had enrolled in graduate or professional school programs (this number includes teaching/graduate assistants who were involved with MTBI over the course of multiple years). Two hundred five (205) are underrepresented minorities (73% of all MTBI US participants who entered graduate or professional schools were URM). To date 129 US MTBI student participants have completed their Ph.Ds., 97 of whom are URM; 75% of US MTBI Ph.D. recipients are URM.

Further, taking into consideration gender (as US women are an underrepresented group in the mathematical and life sciences at the doctoral level) the results are even more dramatic. Of the 129 US MTBI student participants who have earned Ph.Ds. 117 (or 90%) belong to an underrepresented minority and/or underrepresented group (including Asian and White/mixed females).

The breakdown in these Ph.Ds. is three Asian-American females; 34 US Latinas; 17 U.S. White/non-URM mixed females; eight African American females, plus 17 foreign females; 44 US Latinos; 10 African American males; 11 White/other males, one Native male and 15 foreign males. Nearly 80% of all MTBI alumni receiving Ph.Ds. are US citizens or permanent residents. The number of Ph.D. recipients, including international participants (15 male and 16 female), climbs to 161 (September 2018) and includes 82 males (44 Latino, 10 African-American, one Native male, one Asian-American male, 15 international and 11 White/other) representing approximately 51%. The 79 female Ph.Ds. (34 Latina, three Asian-American, eight African-American, 17 U.S. White/other and 17 international) account for 49%. Overall, 148 out of these Ph.Ds. have been awarded in 2006 or later, 119 since 2008.

MTBI students have also been prolific researchers, with a large number of refereed publications. And the numbers of MTBI alumni affiliated with various universities continues to grow. At Arizona State University, undergraduate and graduate degree programs in Applied Math for the

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<sup>2</sup> <http://mtbi.asu.edu/>

Life and Social Sciences (AMLSS) have attracted and support a large number of URM students. The AY18 graduate program of 20 students was comprised of eight underrepresented minorities with six having participated as undergrads; 15 of the 22 have participated as grad assistants. New students are participating in the 2018 summer program. All receive continued mentoring as graduate students. In addition, large communities of MTBI alumni have been established at institutions that include the University of Iowa Mathematics Department (11 Ph.Ds. since 2005, including eight URMs); Cornell University, 22 Ph.Ds., 18 to URM since 2003); and Arizona State University (54 Ph.Ds. since 2006, 34 to URMs). Within the AMLSS program alone, we have awarded 39 Ph.Ds. since 2008, 26 (67%) to URM students. In sum, the efforts of the MTBI family its directors, faculty, graduate students, and the participants themselves has significantly increased the national rate of production of U.S. Ph.Ds. since the inception of the institute. MTBI and its network continue to address the need for programmatic changes and scholarly environments, which support and enhance underrepresented minority success in the mathematical sciences. Past participants who have received their doctorates continue to support the program as returning faculty, bringing the cycle full-circle.

An illustration of MTBI PhD degrees follows:

Total PhD degrees	161
Applied Math, AMLSS	68
Mathematics	38
Math Biology, Math Ecology	9
Biometry, Bio Informatics	6
Biostatistics	4
Statistics	3
Various Engineering	7
Computer Science	3
Epidemiology	2
Others	17

Others	21
Amer/African American Studies	1
Atmospheric/Oceanic Sciences	1
Celestial Mechanics	1
Chemistry	1
Cognitive Psychology	1
Education	1
Genetics	1
Geophysics/ Tectonics	1
International Health	1
Math Education	4
Molecular Biology	1
Neuroscience	1
Philosophy	1
Physics	1
Public Health	1
Scientific Computing	1
Social Epidemiology	1
Urban/Tech/ Enviro Planning	1

MTBI was recognized as a “[Mathematics Program that Makes a Difference](#)” by the American Mathematical Society<sup>3</sup> and with a [PAESMEM](#) (White House) Award in 2011<sup>4</sup>. Its founder, CCC<sup>5</sup>, was recognized with an individual [PAESMEM](#) White House Award in 1997.

<sup>3</sup> <http://www.ams.org/programs/diversity/emp-citation2007>

<sup>4</sup> <http://paesmem.net/awards/institutions/228>

<sup>5</sup> <http://paesmem.net/awards/individuals/14>

## **The Joaquin Bustoz Math-Science Honors Program (JBMSHP) and The Strengthening the Understanding of Mathematics and Sciences (SUMS) Institute <sup>6</sup>**

The Joaquin Bustoz Math-Science Honors Program (JBMSHP), supported by the Strengthening of Understanding of Mathematics and Sciences (SUMS) is a summer residential mathematics program intended for mature and motivated students who are interested in academic careers requiring mathematics, science, or engineering-based coursework and who are typically underrepresented in those fields of study. Selected participants include first-generation college bound students and students representing diverse backgrounds from high schools throughout the State of Arizona, including rural communities and the Navajo Nation.

Participants live on the Arizona State University (ASU) Tempe campus while enrolled in a university level mathematics course for college credit such as College Algebra, Pre-Calculus, Calculus I, Calculus II, or Applied Mathematics in the Life and Social Sciences. In addition to the coursework, students work in groups to conduct applied mathematics research involving real-life mathematics problems to help deepen their understanding of the class material. Students present their findings in an oral presentation to their class peers and JBMSHP staff as well as at a poster symposium for faculty, staff, and family members. Tutoring and problem-solving sessions are provided as well as a variety of academic presentations and activities. Tuition, room and board, textbooks, and classroom expenses are provided at no cost to the student.

Since its inception, 2,820 students have participated in the JBMSHP. 58% of the participants have been female. 50% are Hispanic, 16% are Native American, 13% are Asian, 13% are Caucasian, and 8% are African American. 35% of the students who attend the JBMSHP attend for multiple summers, earning as many as 11 university credits before enrolling at a university as a first-time freshman. 59% of all JBMSHP alumni students have attended ASU after their high school graduation, and 71% currently attending ASU are majoring in a science, technology, engineering, or mathematics (STEM) field. JBMSHP alumni consistently earn higher grade point averages when compared to non-JBMSHP students at Arizona State University within the College of Liberal Arts and Sciences, the Ira A. School of Engineering, and the W.P. Carey School of Business. As of fall 2017, JBMSHP alumni grade point average compared to those non-JBMSHP alumni currently at Arizona State University is 13% higher within the College of Liberal Arts, 11% higher within the Ira A. School of Engineering, and 14% higher within the Mary Lou Fulton Teachers College.

As of the summer of 2017, JBMSHP alumni have earned 1,244 degrees from ASU, with 1,079 undergraduate degrees and 165 graduate degrees earned from ASU. 59% of JBMSHP alumni who have earned a degree from ASU are female, 52% are Hispanic, 18% are Asian, 11% are Native American, 12% are Caucasian, and 7% are African American. 159 JBMSHP students have graduated from ASU as part of Barrett, The Honors College. Since 1985, 73% of all JBMSHP alumni who attended ASU earned a degree from ASU.

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<sup>6</sup> <https://jbmsHP.asu.edu/>

Following the success of the Math-Science Honors Program (MSHP), Dr. Joaquín Bustoz established the Strengthening the Understanding of Mathematics and Science (SUMS) Institute in 1995. The SUMS Institute, which housed the MSHP, has received national recognition as a leader in the recruitment, retention, and graduation of students from underrepresented groups in fields requiring a mathematics or science curriculum. For his many successes in encouraging minorities to earn degrees in mathematics and science, the National Science Foundation honored Dr. Joaquín Bustoz individually in 1996 and the SUMS Institute in 2003 with the prestigious Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. He received numerous teaching awards, including the Wexler Award at ASU, and, in 1996 and 2002, he received the ASU Alumni Association's Outstanding Faculty Service Award.

In 2002 SUMS was awarded the Presidential Awards for Excellence in Science, Mathematics & Engineering Mentoring<sup>7</sup>. In 2007 the JBMSHP received the Pathways to Higher Education Award by the Arizona Commission for Postsecondary Education, in honor of significant leadership in the field of college outreach, transition, and student success, and in 2015 was honored with the Pathways to Postsecondary Integrated Impact Award by the Arizona Commission for Postsecondary Education. In 2016, the JBMSHP was a national finalist for Examples of Excelencia, an initiative to identify and promote programs, departments, and community-based organizations at the forefront of advancing educational achievement for Latino students in higher education.

### **Latin American Consortium on Environment - mathematics, biology & engineering (LACEmbe)**

Inspired by the United Nations Development Sustainable Goals and a profound desire to implement them in the context of the Caribbean and Latin America, a group of researchers, scientists, engineers, public health officials and educational leaders, from Colombia, Ecuador, Mexico and other Latin American nations, the USA and Canada, has resolved to formalize and strengthen their commitment to work on these goals, through the establishment of a consortium of institutions, centers, and individuals.

Our Vision: to transform research and educational dynamics in the Caribbean and Latin America through the development of innovative solutions by addressing the challenges posed by Vector Borne and communicable diseases; establishing Sustainable Environmental, Health and Social Systems; and building a strong workforce in Science Technology and Innovation.

Our Mission: to establish trans-national transformative partnerships to solve high impact regional problems.

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<sup>7</sup> <http://paesmem.net/node/1723>

Our Values: respecting local norms, practices and aspirations; commitment to the interests of the communities of stakeholders; promotion of the ethical well-being of all stakeholders; commitment to the sustainability, growth and resilience of regional scientists; engagement in education and outreach; broadening participation through the inclusion of underrepresented groups

The First International and Interdisciplinary Workshop on the Ecology, Evolution and Dynamics of Dengue and other Related Diseases was held at Arizona State University, Tempe, August 4 - 5, 2014, a two-day symposium co-sponsored by the Levin Center, and the Biodesign Institute's Center for Infectious Diseases and Vaccinology (directed by Roy Curtiss III) Three more conferences have taken place, two in Colombia and one in Ecuador. The results include joint publications, visits, research proposals and more.

### **Applied Mathematics in the Life and Social Sciences Doctoral Program (AMLSS)<sup>8</sup>**

In a world beset by rapidly accelerating social and environmental dilemmas, there is an urgent need for a large pool of scientists who are capable of applying advanced quantitative and qualitative approaches who also have deep insights into the challenges of societal and environmental dynamics. The Applied Mathematics for the Life and Social Sciences (AMLSS) doctoral degree is designed especially for students who want to make innovative and far-reaching scientific contributions to the global challenges of our time. Students learn a way of thinking that builds upon foundations established in mathematical epidemiology, genomics, population dynamics, bioinformatics, ecology, computational sciences, mathematical analysis and the social science fields. They experience real interdisciplinary learning that interweaves theory, applications and analytical approaches with cross-disciplinary and international collaboration. Students with strong and potentially diverse scientific and cultural backgrounds will find a natural home in this field.

*"Our [Ph.D.] goal is to produce a new generation of scientists with an understanding of global issues and vigorous training in quantitative theory and methods. Our graduates come from a wide range of backgrounds and will be able to quickly adapt to the changing employment demands we are already seeing in areas such as homeland security, sustainability and conservation biology, urban system dynamics, public health, disease evolution and addiction, infrastructure and technological research."*

AMLSS was established in 2008 by Dr. Carlos Castillo-Chavez. Its notable accomplishments include:

39 doctoral students since 2008— 26, or 67%, are underrepresented minorities.

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<sup>8</sup> <https://shesc.asu.edu/degrees/applied-mathematics-life-and-social-sciences-phd>

### PhDs from US by nationality

<b>Total PhDs</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
US	20	12	<b>32</b>
International	5	2	<b>7</b>
<b>All PhDs</b>	<b>25</b>	<b>14</b>	<b>39</b>

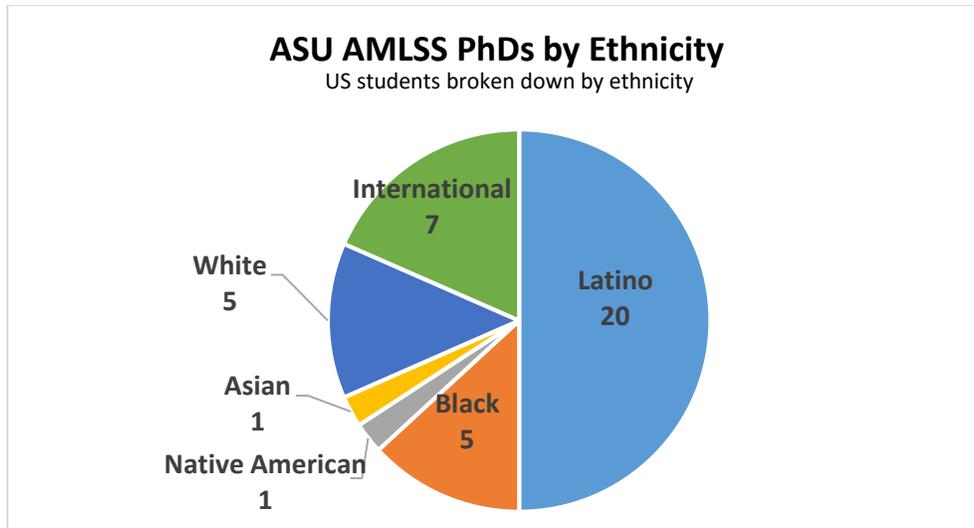
### PhDs from US by minority

<b>Total PhDs US</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
URM	16	10	<b>26</b>
US Non-URM	4	2	<b>6</b>
<b>Total</b>	<b>20</b>	<b>12</b>	<b>32</b>

### PhDs from US by ethnicity

<b>Total PhDs US</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
Hispanic	10	10	<b>20</b>
Black	5	0	<b>5</b>
Native American	1	0	<b>1</b>
Asian	1	0	<b>1</b>
White	3	2	<b>5</b>
<b>Total</b>	<b>20</b>	<b>12</b>	<b>32</b>

In 2012, AMLSS awarded ASU's first ever PhD degree in mathematics to an African American, Edme Soho, with a current total of five African American recipients. Furthermore, Adrian Smith became the first Native American to earn a PhD in the mathematics, via the AMLSS degree in 2016.



AMLSS graduates have secured positions in academia at such prestigious institutions as Harvard University, Sloan Kettering Cancer Center, and Vassar College. Private employers include Goldman Sachs, JP Morgan Chase, and American Express. Several serve in government institutions such as the US Army Engineering Research and Development Center and the US Department of Veterans' Affairs. AMLSS students work in such diverse areas as biology, engineering, physics, public policy, and mathematics education.

ASU also supports an Applied Mathematics in the Life and Social Sciences undergraduate degree program.

### **Sponsored Projects of Particular Note**

The Center is fortunate to receive support for a variety of organizations and government agencies that underwrite the work of its programs. Key longstanding grants include:

Financial support for MTBI:

- National Science Foundation
- National Security Agency
- The Alfred P. Sloan Foundation

Financial support for JBMSHP:

- Western Alliance to Expand Student Opportunities (WAESO)

Several programs in particular have strongly supported the Center's goals of intentionality in creating opportunities for students to achieve stated objectives: the National Science

Foundation's International Research Experience for Students (IRES) grant and the Louis Stokes Alliance for Minority Participation Bridge to the Doctorate (BD) program. Brief descriptions follow:

### **IRES at MCMSC**

From 2015-2017 NSF provided financial support for a three-year International Research Experience for Students (IRES) designed to take MTBI participants to the next level in collaborative research. The IRES Population Dynamics and Complex Systems program took place in Universidad de Los Andes in Bogotá, Colombia. The experience was made up of three components: an approximation to a Spanish speaking community in a developing country; the development of a high quality research project in collaboration with students from Universidad de Los Andes (UNIANDES); and a visit to protected area subject to human pressure and containing endangered species that are subject of current investigation.

The brief immersion to this new culture included getting to know entirely new surroundings, a new university environment, and new cultural activities. The program included a hands-on four-day field trip that provided context to the students' projects and gave them their first experience of fieldwork. They visited areas with high biodiversity populated by communities that face complex challenges (including the risk of tropical diseases).

Students participated in research groups, assisted in mentoring local students, and prepared final presentations that included a written report (a manuscript formatted to be submitted to a journal) and an oral presentation. Eight students participated in the program, three of whom attended two years (first as new students, then as advanced participants). This program afforded students the opportunity to connect in a way completely foreign to them, to create new collaborative relationships as well as to learn more about a culture dramatically different from their own. The experience enriched the personal and academic lives of all participants, both US and international.

### **Bridge to the Doctorate (BD)**

The Bridge to the Doctorate program at ASU aims to increase the pool of qualified URM doctoral applicants with strong quantitative competencies for STEM PhD programs across the nation. ASU's proven pipeline serves as a strong backbone for the BD, while its focus on self-selected research and interdisciplinarity allows students to control their own professional destinies while bolstering the strength of our nation's STEM talent pool and enhancing national security and competitiveness.