Interdisciplinary inclusive communities of undergraduate doing social-justice inspired researcher:

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BROWN

ARIZONA STATE UNIVERSITY

SIAM CONFERENCE ON THE APPLICATIONS OF DYNAMICAL
SYSTEMS, SNOWBIRD UTAH
Interdisciplinary Inclusive Communities of Undergraduates doing
Social-Justice Inspired Research

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The basic reproduction number for the SIR model without vital dynamics-mass action law
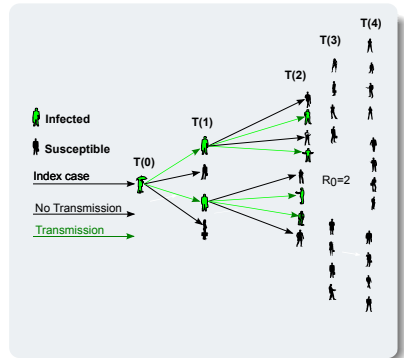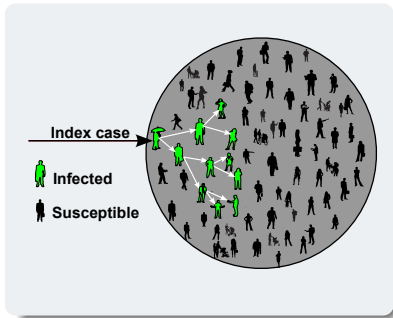
The basic reproduction number, $\mathcal{R}_0$, defined as the number of secondary cases generated by a typical infectious individual during its period of infectiousness in an entirely susceptible population.

## The Establishment of a Community of Infectives

Establishment of a Critical Mass of Infectives!
$\mathcal{R}_0 > 1$ implies growth while $\mathcal{R}_0 < 1$ extinction.
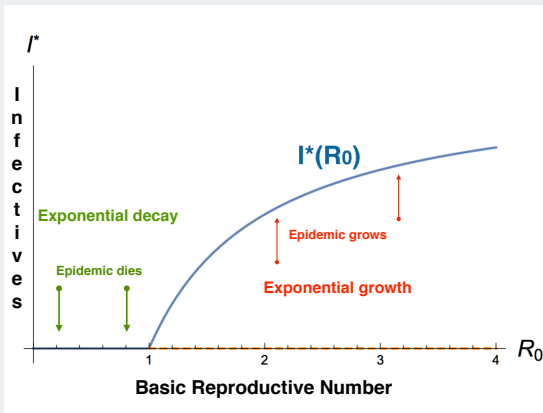
Tipping Point

"The tipping point is that magic moment when an idea, trend, or social behavior crosses a threshold, tips, and spreads like wildfire. Just as a single sick person can start a flu epidemic, so too can a small but precisely targeted push cause a fashion trend, the popularity of a new product, or a drop in the crime rate. This widely acclaimed bestseller, is already changing the way people throughout the world think about selling products and disseminating ideas."

The Tipping point by Malcolm Gladwell
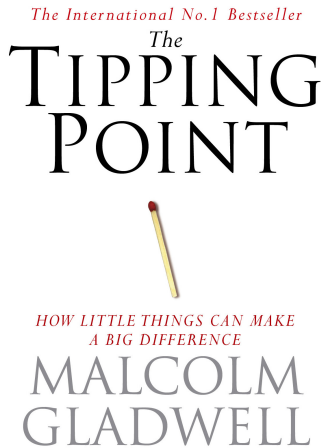
Creating Resilient Communities – Initial Conditions Matter

In the study of spread of extreme behaviors, drug addiction, gang dynamics, drinking dynamics and in populations where behavioral changes take place or are induced: we see hysteresis emerging at the population level. In other words, $\mathcal{R}_0$ is not the key since Initial Conditions play a role. Where you start matters!

Bifurcation diagram as a function of R_0
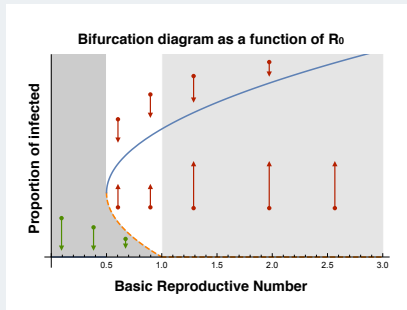
**Meritocracy cannot be defined without considering INITIAL CONDITIONS**

**The promises of our democracy cannot be fulfilled selectively. Therefore, a
social justice educational model that does not account for:**

1. Initial conditions: family background, quality of schools, access and resources.

   ...a model that does not eliminate the deleterious impact of

2. Preconceived notions of ability and talent that a priori disempower those with a
   history of exclusion

   A model that...

3. asks us to wait until K-12 education is perfect must be put out of commission as
   no family, white, yellow, brown or blue can possibly accept the sacrifice of a
   single generation... delays in access are unacceptable

   I system where inequality is pervasive cannot be called a meritocracy.

Simple Collaborative Active Learning Model-Building Resilient Communities

▶ Community Resilience in Collaborative Learning, **Crisosto, M.
N., C., Kribs-Zaleta, C Castillo-Chavez and S Wirkus**,
Discrete and Continuous Dynamical Systems B,
Volume 14, No 1, pages 17-40, July 2010.
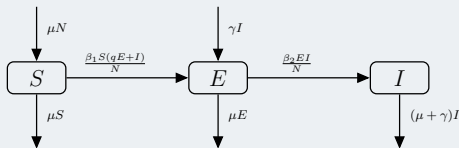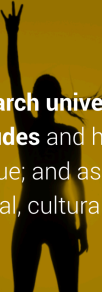
$S(t)$	Naive (Susceptible)
$E(t)$	Semi Convinced
$I(t)$	Completely Convinced

Individual Based Model $\mathcal{R}_0$ Impact - WITH Multilevel Cooperation–ICsMatter

Bifurcation diagram as a function of R0
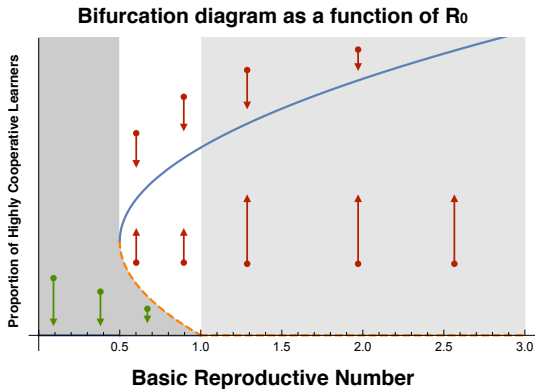
ASU Charter – Initial Conditions Matter

ASU charter

ASU is a comprehensive **public research university**, measured not by whom it excludes, but rather 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.

The Simon A. Levin Center – Dedicated to Socially-Driven Research

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 within a model of inclusion.

The Simon A. Levin Center: Key Programs that address the impact of ICs

- ▶ JBMSHP & SUMS -High School Non Remedial
- ▶ MTBI - Undergrad Research
- ▶ AMLSS Doctorate Program
- ▶ LSAMP Bridges to the Doctorate
- ▶ NSF's International Research Experience for Students
- ▶ The Latin American Consortium on Environment - Mathematics, Biology & Engineering (LACEmbe)

JBMSHP and MTBI have received Presidential Awards

Joaquin Bustoz Math-Science Honors Program - 10-12 grades

2019 JBMSHP courses

8-week session: May 28 – July 19, 2019
- MAT 270: Calculus I
- MAT 271: Calculus II

6-week session: June 10 – July 19, 2019
- AML 100: Intro to Applied Math
- MAT 117: College Algebra
- MAT 170: Pre-Calculus

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program

Applied math research

- Students will use math software to perform research on a real-life applied math problem.

- Groups will present findings at a poster symposium

- Examples of research topics:
  - Curbing CO2 levels
  - Costs of launching rockets into space
  - Solar energy costs on homes
  - Effects of prescription rates on the opioid epidemic

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program –nearly 3000 participants

JBMSHP overview (1985-2018)

JBMSHP participant highlights

58%:	Female participants
86%:	Received a B grade or higher
35%:	Participated 2 or more summers
82%:	First-generation students since 2005

100%
Graduated from
high school
(since 2005)

99%
College
attendance
after high
school   (since
2005)

59%
Attended ASU
after high
school
(since 1985)

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program

Current JBMSHP Alumni Enrolled at ASU

JBMSHP alumni at ASU (Fall 2018)

182:   Students currently enrolled at ASU

30:   Current graduate students

3:   Current high school students enrolled at ASU

76%:   Pursuing a science, technology, engineering or mathematics (STEM) major

54%:   Female students enrolled

66   JBMSHP alumni enrolled at Barrett, The Honors College, named "the gold standard" among honors colleges by the New York Times*

* Bruni, F (2015). "A Prudent College Path." New York Times, https://www.nytimes.com/2015/08/09/opinion/sunday/frank-bruni-a-prudent-college-path.html

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program – Inclusivness

JBMSHP Alumni Degrees Earned at ASU

Degrees Earned by Discipline

Other   Business   Education   Liberal Arts   Engineering

Degrees earned by ethnicity

African American   Asian   Caucasian   Hispanic   Native American
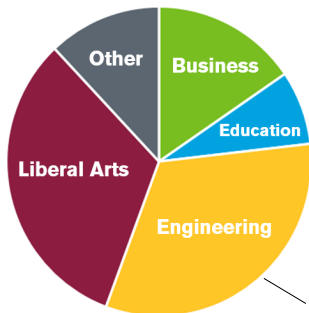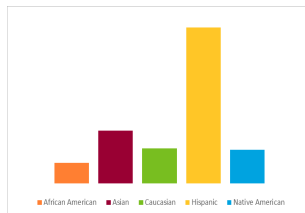
1,307 ASU degrees earned

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program

JBMSHP Alumni Degrees Earned at ASU

JBMSHP degrees earned highlights

1,124:	Undergraduate degrees earned
183:	Graduate degrees earned
232:	Received multiple degrees at ASU
173:	Earned degrees while enrolled in Barrett, The Honors College
70%:	Graduated with a 3.0 grade point average or higher
42%:	Graduated cum laude (3.40 grade point average) or higher
59%:	Degrees earned by females

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program

JBMSHP Alumni at other Universities

249 JBMSHP alumni currently attending a Non-ASU institution

976 JBMSHP alumni who have earned a Non-ASU degree

61% Female JBMSHP alumni earned a Non-ASU degree

Joaquin Bustoz
Math-Science Honors Program

Joaquin Bustoz Math-Science Honors Program

JBMSHP Alumni at Work

Joaquin Bustoz
Math-Science Honors Program

MTBI Sites

The Mathematical and Theoretical Biology Institute MTBI

$1996 - 2002 : Cornell\ University$

$2003 - 2005 : Los\ Alamos/Cornell/ASU$

$2006 - ????: Arizona\ State\ University$

MTBI: Collaborative Learning Model

1. Common Language: Includes intense academic component (4 weeks)
2. Relevance: Scientific Agenda driven by students questions
3. Absence of Hierarchies–faculty and students are collaborators
4. Collaborative Learning Philosophy that promotes leadership
5. Students come from primarily non-selective institutions
6. Stress a product (paper) that is tied in to the students scientific agenda
7. Continuous participation as participants or mentors
8. Membership on a community that stays close "forever"
9. Preparation for and support while in graduate school
10. Ran like an NSF institute-committed faculty-Typically from other institutions
11. Accountability-via number of advanced degrees, MS and Ph.D.s
12. AGEP, LSAMP, VIGRE, IGERT, AGEP, LSAMP, NSA, Sloan

The Theory of Learning

Albert Bandura

Lev Vygotsky

Jean Piaget

▶ Lev Vygostky explored how social environmental factors influence individual development; theory of learning is the zone of proximal development.

▶ Jean Piaget explored the social theory of learning: how knowledge develops; "intelligence organizes the world by organizing itself".

▶ Albert Bandura (social cognitive theory) explored social factors that affect behavioral change rather than the details of mental activity and its development.

Cooperative Learning: MTBI Model

Nicolas Crisosto

Question:
Can cooperative learning build resilient communities of learners?

▶ Community Resilience in Collaborative Learning, **Crisosto, M. N., C., Kribs-Zaleta, C Castillo-Chavez and S Wirkus**, *Discrete and Continuous Dynamical Systems B, Volume 14, No 1, pages 17-40, July 2010.*
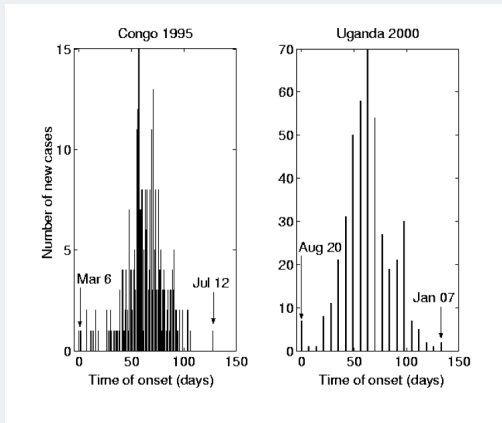
MTBI Example: Ecstasy - PUBLISHED

Melissa Castillo-Garsow
Marcin Mejran
Karen Rios-Soto
Leilani Henson

Question:
How can we stop the
spread of Ecstasy?

Ebola–Gerardo Chowell

A most cited paper in Ebola – ideas MTBI 1996 and 1999

Research: Students' Agenda ... a few examples

▶ Am I too fat? Bulimia as an epidemic
The Journal of Mathematical Psychology (47 (2003) 515-526)
First paper ever on the dynamics of bulimia

▶ Effects of education, vaccination and treatment on HIV
transmission in homosexuals with genetic heterogeneity
The Journal Mathematical Biosciences (187 (2004) 111-133)

▶ Community Resilience in Collaborative Learning
**Crisosto, M. N., C., Kribs-Zaleta, C Castillo-Chavez and S
Wirkus**,
Discrete and Continuous Dynamical Systems B,
Volume 14, No 1, pages 17-40, July 2010.
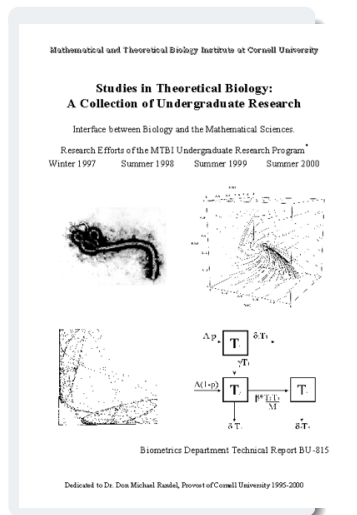
MTBI Inaugural Class

MTBI 1996

Erika Camacho

Selected References on MTBI

► Castillo-Garsow, C.W. and C. Castillo-Chavez: "Why REUs Matter"; In Peterson, M. (Ed). REU: New Directions. World Scientific (in press)

► Castillo-Garsow, C.W. and C. Castillo-Chavez, "A Preliminary Theoretical Analysis of an REU's Community Model," Problems, Resources and Issues in Mathematics Undergraduate Studies, Volume 23, Issue 9, pages 860-880, 2013

► Crisosto, M. N., C., Kribs-Zaleta, C Castillo-Chavez and S Wirkus, "Community, Resilience in Collaborative Learning," Discrete and Continuous Dynamical Systems B, Volume 14, No 1, pages 17-40, July 2010

► Castillo-Chavez C and C. W. Castillo-Garsow, "Increasing Minority Representation in the Mathematical Sciences: Good models but no will to scale up their impact," In: Doctoral Educations and the Faculty of the Future, Edited by, Ronald G. Ehrenberg and Charlotte V Kuh, pages 135-145, Cornell University Press (2009)

► Castillo-Chavez, C., C. W. Castillo-Garsow, G. Chowell, D. Murillo, and M. Pshaenich, "Promoting Research and Minority Participation via Undergraduate Research in the Mathematical Sciences. MTBI/SUMS-Arizona State University," In: Proceedings of the Conference on Promoting Undergraduate Research in Mathematics, Edited by Joseph Gallian, pages 15-22, American Mathematical Society, AMS, June, 2007

► Tennenbaum, S. "Research and Education Activities of the Mathematical and Theoretical Biology Institute at Cornell," In (Joseph. A Gallian, Ed.) Proceedings of the (1999) Conference on Summer Undergraduate Mathematics Research Programs[6], pp. 37-49, 2000

Twenty-Two Years of MTBI Results

- ▶ 507 undergrad (420 US; 290 URMs)

- ▶ 78 attended multiple times

- ▶ Over 180 Grad students mentored

- ▶ Through July 2017, 281 out of 420 have enrolled in professional or graduate school (205 URMs)

- ▶ Over 220 technical reports produced; many published in referred journals

Mathematical and Theoretical Biology Institute at Cornell University

**Studies in Theoretical Biology:
A Collection of Undergraduate Research**

Interface between Biology and the Mathematical Sciences.

Research Efforts of the MTBI Undergraduate Research Program
Winter 1997 Summer 1998 Summer 1999 Summer 2000

Biometrics Department Technical Report BU-815

Dedicated to Dr. Don Michael Randel, Provost of Cornell University 1995-2000

Twenty-Two Years of MTBI Results

► 164 PhDs earned; 131 US (33 Int.)
  - 97 US-URMs - 117 URGs; most over
  the past 10 years

	Male	Female	TOTAL
Hispanic/Latino	43	34	77
African American	10	8	18
Native American	2	0	2
White	11	18	29
Asian American	2	3	5
Foreign/other	16	17	33
TOTAL	**84**	**80**	**164**

Where have they gotten some of their PhDs?

Cornell 23 - 18 URMs since 2003
Iowa 11 PhDs since 2005 including 8 URMs
ASU 56 PhDs since 2006 including 34 URMs
AMLSS PhD program @ ASU established in 2008- 39 PhDs and
26 URMs

164 PhDs and Counting

PhD Degrees	164
Applied Math, AMLSS	68
Mathematics	41
Math Bio, Math Ecology	9
Biometry, Bio Info	6
Biostatistics	4
Statistics	3
Other	33

Other	33
Various Engineering	7
Education, Math Education	4
Computer Science	3
Epidemiology	2
Amer/Afr Amer Studies	1
Atmo/Oceanic Sciences	1
Celestial Mechanics	1
Chemistry	1
Cognitive Psychology	1
Genetics	1
Geophysics/Tectonics	1
International Health	1
Math Sociology	1
Molecular Biology	1
Neuroscience	1
Philosophy	1
Physics	1
Public Health	1
Scientific Computing	1
Social Epidemiology	1
Urban/Tech/Enviro Planning	1

MTBI Alumni - at CNLS in Los Alamos Natl. Laboratory

MTBI Alumni

Sara del Valle. PhD University of Iowa 2005

- ▶ Leading scientist at Los Alamos National Lab
- ▶ Research Interests: Developing mathematical and computational models for mitigating the spread of infectious diseases.

(EpiSims slides courtesy of Sara del Valle et al.)

MTBI Alumni

Kevin Flores PhD, Arizona State University (2009)

https://facultyclusters.ncsu.edu/people/kbflores/

- ► Filipino Mexican American
- ► Assistant Professor, North Carolina State University (Personalized Medicine)

MTBI Alumni

Johnny Guzmán PhD, Cornell University (2005)

http://www.dam.brown.edu/people/jguzman/home.htm

▶ Mexican American

▶ California State University Long Beach

▶ Associate Professor of Mathematics, Brown University

MTBI Alumni

Brisa N Sánchez PhD, Harvard University (2006)

https://sph.umich.edu/faculty-profiles/sanchez-brisa.html

- ▶ Mexican American and University of Texas at El Paso
- ▶ Professor, University of Michigan
- ▶ Dornsife Endowed Professor of Biostatistics, Drexel University (2019)

MTBI Alumni

Miriam A Nuño PhD, Cornell University (2005)

http://ucd-advance.ucdavis.edu/profile/miriam-nuno

▶ Mexican American - started at Community College

▶ Associate Professor of Biostatistics and In-Surgery Residence, University of California, Davies, 2018-

MTBI Alumni

Daniel Romero PhD, Cornell University (2012)

https://lsa.umich.edu/cscs/people/core-faculty/drom.html

▶ Colombian American and Community College
▶ Assistant Professor of Information,
▶ Electrical Engineering and Computer Science and Complex Systems
▶ University of Michigan

MTBI Alumni

Emilia Huerta Sánchez PhD, Cornell University (2008)

https://www.stat.berkeley.edu/ emiliahs/

▶ Mexican AmericanMills College, Assistant Professor of Ecology and Evolutionary Biology, Brown University

▶ Co-author of Hidden Figures No More, Published in Genetics

▶ 59 percent of programmers recognized in papers acknowledgements' section were women, in the 1970s

MTBI Alumni

Gerardo Chowell PhD, Cornell University (2005)

https://twitter.com/phgsu/status/849981377676226561?lang=bg

- ▶ Mexican American
- ▶ Universidad de Colima
- ▶ Professor, Georgia State University
- ▶ Chair of the Department of Population Health Sciences

MTBI Alumni

Karen Rios-Soto PhD, Cornell University (2008)

http://math.uprm.edu/people/professor2.php?person=Rios%20Soto,%20Karen

- ▶ Puerto Rican (1 of 10)
- ▶ Professor of Mathematics, Universidad de Puerto Rico, Mayagüez

MTBI Alumni

Ryan Hernandez PhD, Cornell University (2010)

https://facultyclusters.ncsu.edu/people/kbflores/

- ▶ Mexican American
- ▶ Associate Professor of Human Genetics, McGill University, 2018-
- ▶ Associate Professor, UC San Francisco

MTBI Alumni

Daniel Rios Doria PhD, Cornell University (2010)

http://archive.disneydataconference.com/2016/speakers.html

▶ Peruvian American

▶ Analytics & Optimization Manager, Walt Disney Parks and Resorts

MTBI Alumni

Carlos Torre PhD, Arizona State University (2009)

https://www.linkedin.com/in/ctorre1/

► Peruvian American

► Vice President, JP Morgan Greater New York City Area

IMPACT: David Blackwell and Richard Tapia and B-T Awardees

Distinguished Lecture Series and Award in the Mathematical and Statistical
Sciences established by MTBI 2000 at Cornell and Cornell - MSRI 2002

- ▶ 2002 Arlie O. Petters (Duke) - Held at MSRI
- ▶ 2004 Rodrigo Bañuelos (Purdue) - Held at IPAM
- ▶ 2006 William Massey (Princeton) - Held at IMA
- ▶ 2008 Juan Meza (Livermore), National Lab Held - SAMSI
- ▶ 2010 Trachette Jackson (Univ. Michigan), Held - MBI
- ▶ 2012 Ricardo Cortez (Tulane University) Held - ICERM
- ▶ 2014 Jacqueline Hughes-Oliver (NCSU) - Held IPAM
- ▶ 2016 Mariel Vazquez (UC Davies) Held - NIMBioS-SAMSI
- ▶ 2018 Ronald Mickens (Clark Atlanta Univ.) Held - ICERM

The foremost African
American Mathematician
America mathematician

"This lecture series provide a unique forum to highlight the current research
of talented African American, Latino and Native American scientists working
in the mathematical and statistical sciences."

Multiple Collaborations - 30 years

When you collaborate ... you may meet interesting people