Recruitment and Retention of Underrepresented Faculty in STEM: The Case of the Mathematical & Theoretical Biology Institute (MTBI)
Experiences From the Field

“Picking tomatoes and cutting apricots with my family in California. I played games and scenarios in my mind to keep me otherwise occupied. I never dreamed of becoming a professor or ever going to college. I grew up doing field work and now, as a qualitative researcher, I find it amusing that I still find myself doing field work.”

Caroline with her Mom, Gabriella, taken at a farm labor camp in California circa 1947
I never left the farm…

- Grew up on farm labor camps
- University of California at Davis, The Farm Campus of the University of California
- Stanford University, also known as “The Farm”
- Now my office is located in the Farmer Building at Arizona State University
On Teaching Values

The university has always taught values, in one way or another...Intentional or not, teaching values occurs in the classroom everyday - in the material I ask students to read, in the dialogue that ensues...Values are implicit in everything I say, write, and do. And so it should be. We teach values by having them...[she argues that the university must] “take seriously and rigorously its role as guardian of wider civic freedoms, as interrogator of more and more complex ethical problems, as servant and preserver of deeper democratic practices.

Toni Morrison, Endowed Professor, Princeton University, Michigan Quarterly Review, Spring 2001
Selected Publications

*Faculty of Color in Academe: Bittersweet Success* (2000) with Samuel L. Myers, Jr.

*Diversifying the Faculty: A Guidebook for Search Committees* (2002). Sold over 15,000 copies.

Recognized Scholar

- 2009 Recipient of the American Educational Research Association (AERA) *Scholars of Color in Education Distinguished Career Contribution Award*
- 2009 Recipient of the AERA *Dr. Carlos J. Vallejo Memorial Award for Lifetime Scholarship*
- 2008 Recipient of the Association for the Study of Higher Education (ASHE) Council on Ethnic Participation *Mildred Garcia Award for Exemplary Scholarship*
- 2008 & 2009 Recipient of the Mary Lou Fulton College of Education *Dean’s Faculty Excellence Award*
Context
Increasing demographic diversity in the U.S. population
  ◦ Heightened awareness of the importance of cross-cultural understanding
  ◦ Student diversity has increased

Benefits of Faculty of color
  ◦ Preparing all students for a diverse society
  ◦ Supporting the success of a diverse student body
  ◦ Assisting in the recruitment of students of color
  ◦ Engagement of new scholarship
  ◦ Student centered approaches to teaching
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*Chronicle of Higher Education Annual Almanac, August 2009*
# Full-Time Faculty Men by Racial/Ethnic Group & Rank, Fall 2007

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*Chronicle of Higher Education Annual Almanac, August 2009*
Full-Time Faculty Men by Racial/Ethnic Group & Rank, Fall 2007

Chronicle of Higher Education Annual Almanac, August 2009
Population of the United States by Race/Ethnicity, 2008

Population of the United States by Gender, 2008

Population of Iowa by Race/Ethnicity, 2008

Population of Iowa by Gender, 2008

Iowa State University Undergraduates & Graduates by Race/Ethnicity, 2008

Iowa State University Graduate Assistants by Gender and Race/Ethnicity, 2009

Iowa State University Post Doctorates by Gender and Race/Ethnicity, 2009

Iowa State University Faculty by Gender and Race/Ethnicity, 2009

Iowa State University Tenure Eligible Faculty by Race/Ethnicity, 2009

Iowa State University Tenured Faculty by Race/Ethnicity, 2009

ISU Undergraduate and Graduate Enrollment in Biological, Physical, & Mathematical Sciences by Gender, 2006

ISU Undergraduate Enrollment in Biological Sciences by Race/Ethnicity and Gender, 2006

ISU Undergraduate Enrollment in Mathematics by Race/Ethnicity and Gender, 2006

ISU Undergraduate Enrollment in Physical Sciences by Race/Ethnicity and Gender, 2006

ISU Graduate Enrollment in Biological Sciences by Race/Ethnicity and Gender, 2006

ISU Graduate Enrollment in Mathematics by Race/Ethnicity and Gender, 2006

ISU Graduate Enrollment in Physical Sciences by Race/Ethnicity and Gender, 2006

Male Minority Mathematical Sciences Doctoral Degree Recipients, 1999-2009

Female Minority Mathematical Sciences
Doctoral Degree Recipients, 1999-2009

Professor Carlos Castillo-Chavez (Arizona State University, in Tempe) pointed out that "For the first time in history, we are experiencing the brain drain that other countries have experienced." The "reverse immigration" of Chinese and Indian scientists and mathematicians who have studied and worked in the U.S. should spur efforts to **increase home-grown talent**. He cited examples of what works at his institution, most notably a high-school summer residential program that attracts Hispanic- and Native-American students, most of whom then pursue science and mathematics studies. He stressed the **importance of undergraduate research experiences**, also funded by NSF, and the importance of the **mathematical sciences institutes**. "We have to produce large numbers of extremely well-qualified scientists and mathematicians," Castillo-Chavez said. "It's not going to take place at the elite universities, but at schools with limited resources".

Congressional Briefing, 9-22-2009

http://chronicle.com/article/Minority-Students-Needed-in/48568/
Mathematical and Theoretical Biology Summer Research Institute
Mathematical and Theoretical Biology Summer Research Institute

- Enrolls students primarily from non-selective colleges and universities with strong academic backgrounds

- 2005: 10 PhDs, 7 URMs, 6 URMs went on to post doctoral appointments at selective institutions

- NSF, Alfred T. Sloan, Office of the Provosts Cornell University and Arizona State University
Cultivating Mathematicians

- The mission of the Mathematical and Theoretical Biology Institute (MTBI) is to produce the best mathematical scientists in the nation. MTBI supports the development of students through educational, research and mentorship activities from high school to the postdoctoral level. Its programs include intensive multiple-summer research training institutes, long-term support for its alumni, continuous research opportunities for undergraduate, graduate and postdoctoral students and opportunities for national and international visitors.
Established in 1996 at Cornell University, MTBI was moved to Arizona State University in the spring of 2004. With the culmination of the 2006 summer institute, MTBI has:

- Mentored 277 undergraduate participants who have produced 111 technical reports.
- Over 60% of its alumni are currently graduate students, or have completed graduate programs, mostly in the mathematical sciences.
- Twenty-four MTBI alumni have earned a Ph.D. in the mathematical sciences—a group that includes fourteen individuals from underrepresented groups.
Carlos Castillo-Chavez
Executive Director of Mathematical and Theoretical Biology Institute (MTBI)

- 2010 Award for Distinguished Public Service, American Mathematical Society (AMS)

- 2007 Advancing Science, Serving Society (AAAS) Mentor Award Recipient

- University Regents and the Joaquin Bustoz Jr. Professor at Arizona State University (ASU)

- Arizona Governor's P-20 Council's Mathematics Alignment Team
Important of Qualitative Methodology for MTBI Case Study

There are advantages to using context-based case study narratives to gain an understanding of continuity and change in universities. Burton Clark (2008), a well-known sociologist of higher education, encourages researchers to focus on concepts derived from actual, successful practice by examining the “truth of diverse stories.”
Study Theoretical Focus

The theoretical focus for this study will be on the sociology of inequality in higher and postsecondary education which examines the sociological impact of college on students, and educational inequality beyond the secondary level. The sociology of higher education literature is categorized in Gumport (2007) by McDonough and Fann in the following three ways:

Individual Level

- Focus on how students influenced by parents, and parents’ educational and occupational attainment.
- Students’ influences on their preparation for-and actions related to access
  - Cultural capital analysis
  - Social-psychological analysis of student stages in aspiration development
  - Cultural & critical analysis (diversity)
- Emphasis on **individual attributes as key determinants**
Organizational Level

- Exploration of how organizations shape and limit educational opportunities and thus student outcomes; Role of how organizations enable/constrain individual action.
- Organizational arrangements and processes within institutions AND linkages between organizations that mediate students’ achievement.
- Organizational contexts as critical to understanding the empirical patterns of student educational outcomes; analyzes schools’ organizational structures, resources, constraints and contingencies.
Field Level

- College access studied as a web of opportunities and structural arrangements.
- Acknowledges and uses organizational & Bourdieuvian perspectives.
- Macro level.
- Simultaneous analysis - Directs attention to the individual, organizational and inter-organizational interests and agency.
  - Integration of individual and institutional analysis by accounting for the reciprocal influences of students and institutions on each other; dynamic interactions of student behavior with professionals’ and policymakers’ practices.
The Mathematical and Theoretical Biology Institute
2009 Summer Research Program Interview Participants

- Total 2009 Interviewees: 27
- Undergraduates: 4
- Graduates: 13
- Faculty: 10
Gender and Race/Ethnicity of Study Participants

- 4 Undergraduates, 1 African American Female and 3 Males (2 Latinos and 1 White)

- 13 Graduates, 5 Female (4 Latina, 1 White) and 8 Males (2 African American, 3 Latino, 1 White, 1 Other, 1 International)

- 10 Faculty, 4 Females (2 Latina, 1 African American/Latina, 1 International) and 6 Males (1 Other, 1 White, 1 Latino/White, 3 Latino)
Years of MTBI Graduate Participation

Participant #
MTBI Case Study: Preliminary Findings

- Individual Attributes
  - Persistence
  - Dedication
  - Sacrifice
  - Passion
MTBI Case Study: Preliminary Findings

- MTBI Programmatic/Organizational Structure and Practice
  - Prepares Students for Rigors of Graduate Study
  - High Quality Instruction from Renowned Scholars
  - Student-Driven Collaborative Research Resulting in Posters, Presentations, and Publications
  - Importance of Team Problem Solving
  - Web of Continuous Challenges Along with Continuous Support so that "no one falls down."
MTBI Case Study: Preliminary Findings

- Field Level or Inter-Organizational Relationships
  - MTBI Connection to National & International Professional Organizations
  - MTBI Connection to Mathematics Programs and Teachers across the country
  - Network Useful Throughout MTBI Participant Career Trajectory
Preliminary Findings

Study participants describe MTBI’s beneficial components such as the process of developing a common language for understanding mathematical concepts and the absence of hierarchies encouraging students to conceive of the mathematical problems they will solve in collaboration with faculty. They also describe the challenges to MTBI such as the lack of incentives for the professoriate, in general, to pursue the goal of correcting underrepresentation … Other preliminary findings point to the importance of team problem solving, a web of continuous challenges for students to achieve their best along with continuous support so that “no one falls down,” and the existence of a national and international MTBI network useful throughout a student’s career trajectory.
Erika Tatiana Camacho

1996 - First MTBI Undergraduate Assistant Professor, Division of Mathematical & Natural Sciences, Arizona State University

2010 - Emerging Scholar Awardee (1 of 12 faculty members selected in U.S.) *Diverse Issues in Higher Education*

2009 - Mentoring Awardee Mathematical and Theoretical Biology Institute (MTBI)/Institute for Strengthening the Understanding of Mathematics and Sciences (SUMS)
Camacho said she has been fortunate to have mentors helping to guide her. First there was Escalante, who was portrayed by Edward James Olmos in the 1988 film "Stand and Deliver." It was in 1990 that Camacho entered Escalante’s algebra classroom at Garfield High School. Then in 1996, when she was an undergraduate student at Wellesley College, Camacho was the first student admitted to the Mathematical and Theoretical Biology Institute (MTBI), a summer program established by Carlos Castillo-Chavez at Cornell University. Its goal is to increase the number of Ph.D.s from underrepresented U.S. populations in fields where mathematical, computational and modeling skills play a critical role.
So this was started at Cornell in 1996, and I didn’t know that it was going to turn out to be this way, but at the beginning I had post docs running the show with me. The first time I told them that we were going to do this, they say, “Okay, what are the parameters?” I told them that essentially we are going to make these students really good researchers in eight weeks, the first three and a half weeks we’re going to teach them lots of mathematics in an effective way…They thought that I was crazy, and then I made it even a little harder. I said, “In addition, the kind of research that they’re going to do is going to be different.” They say, “What do you mean by the kind of research is going to be different?” Yes, they are going to decide what the research questions are.
I remember there were four women sitting—and they asked, what is the impact of alcohol on the brain? And the post docs say, “Well, we don’t know anything about that.” Some of them wanted to quit because they are accustomed to controlling the show. We’re controlling the show, so we look very smart, but we aren’t. How does it matter is if now they say, “Well, you have this much experience, now use that experience to solve something that you don’t know about.”
Carlos Castillo-Chavez
Tap Into Their Passion

“So, one of the things you have to do is give them ownership of what they’re learning. That means adjusting or really trying to use what interests them which most of the time are much more interesting problems than ones we use in the class…Often they are smarter, the undergraduate students, because they are not restricted—by this general idea that this is good research. They have transformed this program that way.”
MTBI Doctoral Students

- **Interviewee 2 (Doctoral Student, Female, Latino, 3)**
  “I think that one of the key ideas that makes it work, that there is always continued support. They won’t let you fail.”

- **Interviewee 7 (Doctoral Student, Male, African-American, 3)**
  “I'd say it teaches you all about grad school. If you can do MTBI, you should be able to do anybody's grad school, anybody's. It teaches you work ethic and how to work with others.”
  “I’ve presented several times– Washington, D.C. and Cameroon, Africa at a medical conference. It was a big experience.”

- **Interviewee 13 (Doctoral Student, Male, International, 3)**
  “So be ready to test your limit of how you can take pressure. Be ready to share your knowledge and be ready to be open minded for different fields that you are not used to.”
MTBI Faculty Members
Programmatic/Organizational Structure and Practice

Interviewee 14 (Faculty Member, Male, White, 11)
“There’s sort of two levels I think of goals of MTBI. One, that we’re trying to get some students interested in research in mathematical biology and perhaps the quantitative sciences more broadly. Two, there’s also a transformational, even revolutionary goal underlying the whole program which is to change the face and the nature of the scientific endeavor.

At a more fundamental level by changing who’s involved in it and also by changing the way the research agenda is set. I think in that regard, MTBI is absolutely unique. Among research programs of which I’m aware in that it allows students to set the research agenda and really makes them more co-equal participants rather than coming to solve some problem that the faculty have already established.”

“If you’re really looking to recruit from a different group and increase the participation of groups who have not historically participated, you have to be willing to and able to recognize that potential in places and in people where it hasn’t been realized yet. And so to some extent you do have to take the risk, and you know, say, ‘Well I think this student has some potential’.”
MTBI Faculty Members
Mentoring

- Interviewee 19 (Faculty Member, Female, International, 5)
  “I think it’s harder actually to be a good mentor than be a good researcher because you have no control most of the time and then you have to adjust to what approach you’re using according to different students. So, I find this more challenging, but at the same time it makes you feel better at the end. If, especially when the students, you know, when they grow and when they achieve something that they never realized they can.”
Interviewee 24 (Faculty Member, Female, African-American/Latino, 3)

“Wow. Well, there’s definitely, I guess, with the student empowerment, feeling empowered that I can do the research. I can do this work. I can do anything, that idea. Then also just simply learning those tools, learning those research skills, learning more about math biology and then also interacting with these top notch scientists. Carlos is world renowned and he brings in people who are also world renowned because they’re his friends.”
MTBI Faculty Members
“Real World” Problem Solving

- **Interviewee 25 (Faculty Member, Female, Latino, 12)**
  “The other programs were not even minority focused or anything like that. I’m glad I did [select MTBI] because that was a program that changed my life. Before that, my goal was to get my double degree in math and economics, but I was thinking about going to investment banking. I mean, at that point, my dream was to go to work on Wall Street one day. I had no idea of going to graduate school or wanting to go to graduate school, but going there and seeing what you could do with mathematics. **You could work on real world problems.**”
  “For example, that summer I worked with my group and we worked on a model for HIV, and also what kind of medication one needs to give to different patients to have a certain outcome to be able to control the HIV.”
MTBI Faculty Members
Dedication and Sacrifice

- Interviewee 25 (Faculty Member, Female, Latino, 12)

  “Running a program like that with that intensity and with that passion really takes everything from your life. You have no personal life. Honestly, it’s the program… because when it’s not the summer you’re recruiting, you’re actively recruiting, and then when you’re not recruiting you’re actually making sure that your students get placed in good graduate programs.”
MTBI Faculty Members
Dedication and Belief

- Interviewee 27 (Faculty Member, Male, Latino, 3)
  “I think the key component here is to have committed people do it like Carlos. People that actually believe that you can actually open doors to Latinos and believe that they can actually do great work, and they can actually change things and do great. I think that’s the key component.”
MTBI Faculty Members
The Ideal Model

- Interviewee 27 (Faculty Member, Male, Latino, 3)
  IDEAL MODEL

- **Leadership**
  - Committed
  - Responsible for Shaping

- **Faculty**
  - Culturally Sensitive
  - Work in Teams

- **Students**
  - Motivated
  - Basic Math Skills
  - Like to Work in Groups
  - Passionate

- A balanced model with half mathematics concepts and half team work focused on ‘real life’ problems
CareerWISE Project
CareerWISE I: Internet-Delivered Resilience Training to Increase the Persistence of Women PhD Students in STEM Fields

The CareerWISE project documents key sources of discouragement and support for women in STEM doctoral programs and offers internet-delivered personal resilience training toward the goal of increasing women's persistence in STEM fields despite challenging circumstances. The CareerWISE online psychological education program will provide information and develop skills for addressing personal and interpersonal challenges in science and engineering environments and strengthening personal assets and supports.

Bianca Bernstein, Director and Principal Investigator, The CareerWISE Project; Professor of Learning, Technology & Psychology in Education, Arizona State University.

Focus groups and semi-structured interviews were used to identify specific elements that encourage or discourage women to persist in completing the PhD. Analysis of focus group and interview data revealed a unique set of challenges and sources of support experienced by women in STEM PhD programs.

- lack of timely success or progress with dissertation research;
- difficulty balancing the demands of academic work with a personal life;
- coping with a professional climate that can be unfriendly toward women;
- and managing a difficult relationship with the primary dissertation advisor.

Women who left PhD programs before earning the degree were found to experience a substantial erosion of confidence during the program and received little or no encouragement to persist.
CareerWISE II: Enhanced Resilience Training for STEM Women in an Interactive, Multimodal Web-Based Environment

- In CareerWISE II, the online resource will be formally evaluated, and the content will be broadened to provide **in depth training on the specific topics of communication and solution-focused problem solving in interpersonal domains**. The CW environment will be expanded to include an **interactive simulation containing multiple critical-incident scenarios**, and an evaluation of effectiveness will be performed.

- The CareerWISE research agenda has two primary threads: 1) characterizing the experiences of women who are pursuing PhDs and leaving PhD programs in STEM disciplines and 2) investigating the effectiveness of the CareerWISE web-based intervention.
Current Doctoral Dissertation Research

Idara Essien-Wood
Dissertation Study of African American Females in the Sciences

- In-depth, semi-structured interviews with 15 African American female undergraduate students in the natural and physical sciences.
- Identified several themes affecting student persistence and academic success:
  - **Environmental Factors:**
    - **Racial/Gender Microaggressions** - Students noted that faculty and peers were surprised that they were intelligent and/or science majors. Students were encouraged by faculty to pursue other majors (e.g., cosmetology, education).
    - **Lack of Diversity** - Students described feeling out of place, as they were the only representatives of their race. Further, faculty often confused students for one another.
    - **Research 1 Environment** - Students noted the existence of a hostile environment where teaching and working with students was secondary to faculty members’ research pursuits.
Dissertation Study of African American Females in the Sciences

- Social Factors:
  - Faculty Interaction - Students reported few, if any, interactions with faculty. When interactions did occur, they were usually brief and negative (demeaning, discouraging).
  - Advisors - Students reported few interactions, often feeling interactions were rushed and/or avoided.
  - Lab Groups - The vast majority of social interaction came from lab groups. Lab group interactions were described in the following ways: a) unfriendly/unwelcoming environments; and b) lack of respect for African American female scientists’ abilities.
  - Teaching Assistants - Students interact with teaching assistants far more than faculty; teaching assistants made them feel at ease with course content.

Literature Synthesis on Faculty of Color
Review of Literature Related to Faculty Diversity by Type of Publication, in 5-Year Increments

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Supports (+) & Challenges (-): Within and Across Departmental, Institutional, and National Contexts

Recommendations for Departmental/Institutional/National Contexts

Departmental

* Establish More Inclusive Standard for Judging Faculty Yearly Performance
* Provide Opportunities for Authentic and Spiritual Expression

* Establish Recruitment / Hiring / Retention Plans
* Diversify Student Body / Faculty
* Provide Training on Faculty of Color Issues
* Provide Opportunities for Collegial Networks and Collaborations

Institutional

* Institutionalize Diversity Goals
* Promote Strong Leadership for Diversity

* Provide Research Support
* Promote Mentoring Programs

National

* Provide Connections to Diverse Communities
* Reduce Salary Inequities

* Promote Policies Supportive of a Diverse Faculty
* Establish More Inclusive Standards for Tenure / Promotion

Further Research

- Further work is needed to capture insights from other sources: conference papers, videos, websites.
- Most published manuscripts focus on faculty of color within public four-year university settings. There is a lack of literature on faculty of color within:
  - community colleges
  - technical colleges
  - private colleges
  - faith-based colleges
  - for profit colleges
- There is almost nothing written on issues related to faculty of color and the intersection of race/ethnicity and sexual orientation.
Implications

- This review/synthesis of extant literature published over a 20 year period highlights the complexity of issues facing faculty of color in higher education.

- The literature collected for this study addresses supports, challenges, and recommendations that cut across departmental, institutional, and national contexts.

- Those involved in making policies and decisions may find this analysis useful in understanding the interrelated factors affecting faculty of color hiring and persistence.

- Transcending context and time frame, mentoring is imperative to faculty of color hiring and persistence.
Shore Up Support: Stem Waste of Talent

• By itself, then, the underrepresentation in the critical technical workforce represents a tremendous waste of talent, the scale of which is increasing as minority populations grow” (p. 125).

• “While it is important to do further research to increase our understanding of minority issues in general and student attrition versus persistence in particular, most universities would do better now to shore up mentoring and student support programs than to create yet another task force” (p. 132).


References