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Linda Braddy Vice President for Academic Affairs





- In social dynamics, **critical mass** is a sufficient number of adopters of an innovation in a social system so that the rate of adoption becomes self-sustaining and creates further growth.
- The good news: The mathematical sciences community is finally reaching a critical mass with regard to **improving undergraduate mathematics education** on a national scale.

- TPSE Math meeting in D.C. last weekend (http://www.tpsemath.org/chairs2016)
- Peter Carlson, David Redman (Delta College), Victor Piercey (Ferris State), & I (all here at MiscMATYC)
- Jane Tanner, AMATYC president
- 132 attendees, 20 from community colleges
- Many from R1s and liberal arts colleges
- Least represented types of institution: Regional universities, HBCUs, HSIs
- NSF, MAA, APLU, AAAS, Dana Center, Ohio Dept of Ed, National Math Alliance

Rewind to four years ago...

- PCAST "Engage to Excel" (2012)
- "Mathematical Sciences in 2025" (NRC, 2013; Mark Green, UCLA)
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- Response: Common Vision
- Response: TPSE Math

Common Vision Project

- Funded by NSF in 2014
- To develop a shared vision in the mathematical sciences community of the need to modernize undergraduate mathematics programs, especially the first two years.



Common Vision Leadership Team

- Karen Saxe, Principal Investigator, Macalester College
- Linda Braddy, co-PI, MAA
- John Bailer, ASA, Miami University
- Rob Farinelli, AMATYC, College of Southern Maryland
- Tara Holm, AMS, Cornell University
- Vilma Mesa, RUME community, University of Michigan
- Uri Treisman, TPSE, UT-Austin, Dana Center
- Peter Turner, SIAM, Clarkson University

Common Vision Project

- Distilled common themes from **existing** curricular guides:
 - Beyond Crossroads, AMATYC, 2006 (update of Crossroads in Mathematics 1995)
 - Guidelines for Assessment and Instruction in Statistics Education (GAISE) College Report, ASA, 2012
 - Guidelines for Undergraduate Programs in Statistical Science, ASA, 2014
 - 2015 CUPM Guide to Majors in the Mathematical Sciences, MAA, 2015 (update of CUPM Curriculum Guide 2004)
 - Partner Discipline Recommendations for Introductory College Mathematics and the Implications for College Algebra, MAA, 2012
 - Modeling across the Curriculum, SIAM, 2012
 - Undergraduate Programs in Applied Mathematics, SIAM, 2014

- The status quo is unacceptable
- More statistics, modeling, simulation, and computation
- Less traditional lecturing, more 'active learning' techniques
- Multiple pathways:
 - Through developmental education and general education mathematics and statistics requirements
 - Into and through majors in the mathematical sciences
- Increasing role of two-year colleges
- Attention to student transitions & transfer between institutions
- Technology to enhance student learning

Other Important Themes

- Failure rates
 - The high rate of failure in post-secondary math classes is an embarrassment to our profession
 - Math courses are the most significant barrier to degree completion in all fields
- **Developmental courses**: Small % of students make it through
- Student mobility: Most prevalent among low-income students
- **Contingent faculty (part-time, adjuncts)**: Need professional development and support

Other Important Themes

- Student diversity
 - Our inability to attract and retain a diverse population is a dreadful shortcoming that must be remedied
 - 1998: Stiff & Harvey called the math classroom one of the most segregated places in the U.S.
 - Today: Upper-level math classes remain predominantly white
 - Today: The "achievement gap" in math is evident as early as 4th grade
 - It is our responsibility to remove barriers, we should not presuppose minorities and women are less capable or less prepared

Recommendations for Specific Stakeholders

- **Institutions:** Provide instructors with training, resources, and rewards for their efforts to modernize curricula, teaching techniques.
- **Departments:** Update curricula, establish multiple pathways into and through majors, and promote environments that incorporate multiple pedagogical approaches throughout a program.
- **Instructors:** Present key ideas and concepts from a variety of perspectives, employ a broad range of examples and contemporary applications, promote awareness of cross-disciplinary connections.
- **Students:** Learn to communicate complex ideas to collaborators, clients, employers, and other audiences.

Call to Action

- "Collective impact" (Kania & Kramer, 2011)
- Improving teaching and learning requires well-coordinated efforts among
 - Faculty
 - Administrators
 - Employers
 - Professional associations
 - Funding agencies

Building, Collaborating

- NCTM is working to build out from *Common Vision* into the K-12 arena.
- **AMATYC** has begun its latest update of its curricular guide informed by the *Common Vision* report.
- MAA is working on an *Instructional Practices Guide* which will be the first of its kind; involves all five *Common Vision* associations (Diane Briars from NCTM is on advisory board).
- **TPSE Math** is focusing on policy efforts (institution-level, state-level, nationallevel) and engaging math department chairs & administrators (including presidents); informed by *Common Vision*.

- Common Vision was one of the first responses to the PCAST report.
- TPSE is gaining traction across the community, particularly with R1 institutions.
- Implications:
 - Colleges and universities alike are gaining a better understanding of transfer patterns and mobility issues our students face and the need for better transfer and articulation agreements and other partnerships among institutions.
 - The innovative things community college math departments are doing (e.g., pathways) are now being recognized across the spectrum of institutions as viable ways to increase student learning and success.
 - We can celebrate our success and then dig in for more hard work to move these innovations forward.

Moving Forward

- What additional things we can do? What innovations should we scale up?
- Work to remove barriers for students from:
 - Non-college going cultures
 - Generational poverty
 - Under-represented groups (i.e., non-Asian minorities and women)

Common Vision Theme: Diversity, Achievement Gap

- Women and non-Asian minorities (Blacks, Hispanics, and Native Americans) are extremely under-represented in STEM, and in mathematics in particular.
- The "achievement gap" is real.
- See Dave Kung's IBL conference 2015 presentation (link at http://www.davekung.com/dtk/_.._Social_Justice.html)
- National Academy of Sciences report just released (Shirley Malcolm, AAAS)
 "Barriers and Opportunities for 2-Year and 4-Year STEM Degrees"
- Both address the "why" more in depth than we have time for today, but learning the "why" helps us understand "what" we can do.

Hidden Rules

- Definition? (Ruby Payne)
- Unspoken understandings that cue the members of a particular group concerning expectations and behaviors.
- Cueing mechanisms that are not deliberately taught by parents nor are they deliberately taught in college; they are modeled and implied.

Important to remember

- Hidden rules are patterns, but patterns have exceptions
- If you use a pattern to prejudge an individual, you are stereotyping.
- Another common example: Generational differences

Hidden Rules

- Those who know the hidden rules of a group or institution assume that everyone knows them.
- Not knowing the hidden rules in college is often equated with not being intelligent.

Hidden Rules Exist in...

- Religions, clubs, families, work settings, ethnic/racial groups
- Economic classes
 - Poverty (generational poverty: at least two generations)
 - Middle class
 - Wealth

Driving forces

- Poverty: Survival, relationships, entertainment
 - People (relationships) are the basis for security, becoming educated is dangerous because the educated person leaves
- Middle class: Work, achievement, material security
- Wealth: Growing wealth (investments), political & social connections

Money

- Poverty: To be used, spent
 Surviving today, no future orientation
- Middle class: To be earned, managed
- Wealth: To be conserved, invested

Food

- Poverty: Did you have enough? (Quantity)
- Middle class: Did it taste good? (Quality)
- Wealth: Did it look good? (Presentation)

<u>Time</u>

- Poverty: **Present** is most important, decisions are made for the moment based on feelings or survival
- Middle class: **Future** is most important, decisions are made based on future ramifications
- Wealth: **Tradition** is most important, decisions are made based partially on past history

Hidden Rules Exist in...

- Economic classes
- Classrooms, colleges, universities
- Disciplines (mathematics, STEM), departments
- Talk to your neighbor for a minute and come up with an example of a hidden rule in your department or at your college.

Barriers for Generational Poverty Students

- Lack of intergenerational transfer of knowledge about college
- Hidden rules of college
- Lack of their own "future stories"
 - Individual plans for gaining economic stability and moving out of poverty
- Lack of social capital or bridging relationships
 - Connections to overcome the challenges of college

Barriers for Generational Poverty Students

- We can help with these challenges, we can help remove these barriers.
- Faculty with knowledge of the hidden rules of economic class and who understand something about the environment and lives of their students, particularly those from poverty, are better equipped to support student learning, retention, and completion.

Another Barrier: Stereotype Threat

Stereotype Threat

- Unpleasant apprehension arising from the awareness of your risk of confirming, as a self-characteristic, a negative stereotype about ones' group in a situation where the stereotype is relevant. (See http://www.reducingstereotypethreat.org/definition.html)
- Steele and Aronson (1995) showed that Black college freshmen and sophomores performed more poorly on standardized tests than White students when their race was emphasized. When race was not emphasized, however, Black students performed equivalently with or better than White students.

(See http://www.reducingstereotypethreat.org/definition.html)

Stereotype Threat

- Follow-up studies suggest that in situations where their ability is being evaluated, stereotyped students carry an extra weight on their minds related to the stereotypes about their group.
- Performance in academic contexts can be harmed by the awareness that one's behavior might be viewed through the lens of racial stereotypes.

Stereotype Threat

- Other studies also have found performance effects:
 - Women taking math tests
 - Latinos taking verbal tests
 - Low socio-economic status students taking verbal tests
 - Blacks and miniature golf
 - White males taking math tests when compared to Asians

How to Mitigate Stereotype Threat?

- Two theories of intelligence are:
 - Intelligence is fixed, genetically determined and not subject to modification (a.k.a., "fixed mindset"). About 40% of the population endorse this theory.
 - Intelligence is largely malleable and abilities can be increased over time with practice (a.k.a., "growth mindset"). About 40% of the population endorse this theory.
 - "Nature vs. nurture"
 - About 20% of the population don't endorse either theory consistently

- Individuals may hold to the fixed mindset theory with regard to certain domains, but the growth mindset theory with regard to others.
 - E.g., Fixed mindset theorists will endorse statements like "You can learn new things, but you can't really change your basic intelligence."
- Both fixed and growth mindset individuals have the same goal
 - To succeed

- Motivation differs
 - Fixed mindset: "The main thing I want to do is show how good I am at school work."
 - Growth mindset: "I am always seeking to acquire new knowledge and develop new skills," "It's much more important for me to learn things in my classes than it is to get the best grades."
- Attribution differs
 - Fixed mindset: "I wasn't smart enough," "I'm just not good at math."
 - Growth mindset: "The harder you work at something, the better you'll be at it," "I didn't study hard enough", "I didn't go about studying it in the right way."

- Look for these comments among your students.
- Can help you identify their perspective so you can help them adopt a growth mindset.

Sense of Belonging

- Feeling like an accepted member of the group and feeling like your presence and participation is valued by your peers.
- Helps mitigate stereotype threat

Pedagogies that Remove Barriers

- Inquiry-based learning (IBL)
 - Laursen, et al
 - (http://www.colorado.edu/eer/research/documents/IBLmathReportALL_050211.pdf)
- Active engagement
 - Mazur, et al (http://scitation.aip.org/content/aapt/journal/ajp/74/2/10.1119/1.2162549)
 - Freeman, et al (http://www.pnas.org/content/111/23/8410.full)
 - Passive lecturing = Educational malpractice
- Interaction helps close achievement gaps
 - Dave Kung's "10 minute talk test"
 - Linda Slakey, former director of NSF DUE: Success when STEM faculty are embarrassed to lecture for an hour

Summary: What can you do to remove barriers for students?

- Help students:
 - Learn the hidden rules of college. Remember their lack of knowledge of these rules does not mean they lack of intelligence, motivation, or various other qualities we value in students.
 - Develop their own "future stories"
 - Develop relationships that will help them overcome the challenges of college
- Use pedagogies that actively engage students (Freeman, et al, support "traditional lecture = educational malpractice")
- Use strategies that reduce vulnerability to stereotype threat (see following slides)

- Promote a growth mindset about intelligence
 - Adopt a growth mindset yourself because teachers' mindsets affect their pedagogical practices
 - Encourage students to adopt a growth mindset
 - Teach students that intelligence is like a muscle. It is not fixed, but grows with effort
 - Work to eliminate a culture that values "talent" and "innate ability" above effort and engagement
- Remove cues that trigger worries about stereotypes
 - E.g., Don't ask students to report a negatively stereotyped group identity immediately before taking a test (like designating gender or race at the beginning of the SAT and ACT)

- Help students manage feelings of stress
 - Teach students about stereotype threat so that they reattribute anxiety to stereotype threat rather than to the risk of failure
 - Teach students to reattribute anxiety as a potential facilitator (e.g., excitement, anticipation) of strong performance rather than barrier to it
- Support students' sense of belonging
 - Teach students that worries about belonging in school are normal, not unique to them or their group, and are transient rather than fixed
 - Encourage students to base their feelings of belonging on their effort (rather than ability) and engagement.

- Structure interactions (in and out of class) to help all students build supportive networks
- Present tests as serving a learning purpose, convey that you are using them to facilitate learning, not to measure innate ability
- Establish and maintain high standards and assure students of their ability to meet these standards
 - Teach students to view critical feedback as reflective of your high standards and your confidence in their ability to meet those standards
- Recruit positive role models from diverse groups
- Value students' individuality and convey that diversity is valued

I hope you will make it your goal to remove as many barriers as you can!

Contact information:

Linda Braddy Vice President for Academic Affairs

linda.braddy@tccd.edu





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