A Guiding and Informing Tale for Re-envisioning STEM Courses

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As part of an ACS-Mellon funded project "Supporting Diversity and Inclusion in Mathematics and STEM Disciplines", Joel Kilty, Alison Marr, and Alex McAllister lead a major curricular change conversation among the faculty of Centre College and Southwestern University that culminated in a "re-envisioning" of the traditional calculus sequence. This document discusses a curricular change process on a broad level, informed by our experiences during our re-envisioning project.

An Approach to Creating Major Change

While working on an ACS-funded project "Supporting Diversity and Inclusion in Mathematics and STEM Disciplines", two of us read John B. Kotter's book "Leading Change" and recognized that we were essentially working our way through his Eight Stage Process of Creating Major Change:

1) Establishing a Sense of Urgency
2) Creating a Guiding Coalition
3) Developing a Vision and Strategy
4) Communicating the Change Vision
5) Empowering Broad-based Action
6) Generating Short-Term Wins
7) Consolidating Gains and Producing More Change
8) Anchoring New Approaches in the Culture

This guide steps through each of these eight stages, using our experiences in re-envisioning the calculus sequence as a case study.

1) Establishing a Sense of Urgency

On a local level, the cultures of our institutions already include some amount of what might be described as "constructive restlessness" in regards to curriculum design and effective teaching. Faculty are committed to a reflective thoughtfulness about the what and how of teaching with a particular eye toward enabling effective learning for all our students. And more than just thinking about these questions, we are committed to action. The following quote from one our faculty members nicely summarizes this ambient culture.

> Think about the question: is how we are teaching MAT XXX perfect? If we think so, then we are justified in preserving the status quo. If not, then we are compelled to think and reflect – to envision ways in which what we do might be better. And, when we find some idea, to thoughtfully act.

On a national level, multiple studies have confirmed a multi-decade decline in the overall number of undergraduates choosing to pursue and complete science, technology, engineering, and mathematics (STEM) majors. Under-represented minority (URM) and female students are significantly less likely to persist in STEM disciplines, resulting in dramatically lower representation in STEM graduate programs and the STEM workforce. Toven-Lindsey et al. 2105

presents a summary of some of these studies and an analysis of possible causes and responses. Among these various studies, Hurtado et al. 2010 found some particularly striking facts for URM students, including the following:

- URM students entering U.S. colleges are just as likely as their non-URM peers to aspire to complete a STEM major.
- 37.5% of white and Asian-American students completed their STEM degrees after 5 years, while the average completion rates for black/African-American, Latino/a, and Native American students were 22.1%, 18.4%, and 18.8%, respectively.

On a different, but related note, according the U.S. Department of Commerce's ESA Issue Brief #04-11, females make up 48% of the U.S. workforce, but just 24% of the STEM workforce, which results, in part, from lower STEM persistence rates at undergraduate institutions. In addition, Stephens et al. 2012 states that first-generation students often have distinctive needs for support mechanisms as well as cultural norms that are often misaligned with the traditional stances of academic institutions. This combination of needs and misalignment create barriers to the persistence and success of first-generation students in any field of undergraduate study, let alone in STEM disciplines.

Looking at data from our own institutions, we observed that students often struggle in their first semester of STEM courses, in particular, in such courses as Calculus I and General Chemistry I. These courses often have high D/F/W rates and students often have to repeat the courses to continue in the sequence. The D/F/W rates for underrepresented racial and ethnic minorities, Pell Grant eligible students, and first generation students are even higher. This data allowed us to see that our current approach was not serving all students equally and should be reconsidered.

Additional motivation comes from the 2012 PCAST report calling for one million more STEM graduates by 2022. Currently, many of our students stop after the first course in the sequence and many others struggle to even complete that first course. However, if the courses were designed to be more engaging for students from all backgrounds this could motivate students to take additional courses and thus more students may choose to continue in STEM.

Finally, just focusing on mathematics itself, the MAA's "A Common Vision for Undergraduate Mathematical Sciences Programs in 2025" offers a compelling call to action. This 2015 report summarized the findings from studying seven curriculum guides from: American Mathematical Association of Two-Year Colleges (AMATYC), American Mathematical Society (AMS), American Statistical Association (ASA), Mathematical Association of America (MAA), and Society for Industrial and Applied Mathematics (SIAM). The unanimous conclusion of all these guides is that "***The status quo is unacceptable***." The report goes on to call for

- updating curricula;
- articulating clear pathways;
- scaling up the use of evidence-based pedagogical methods;
- removing barriers facing students at critical transition points;

- encouraging student persistence; and
- establishing stronger connections with other disciplines.

In our experience, this confluence of diverse factors established a sense of urgency that lead to genuine change and definitive action. Each group of faculty and students, each collection of courses, each institution, and each academic discipline will have its particular collection of needs and accomplishments, shortcomings and opportunities that can generate the sense of urgency to pursue change.

2) Creating a Guiding Coalition

The development and implementation of a major change effort needs a small, trusted, committed, and empowered group of leaders. While a sizable group of faculty from an entire program or programs may need to ultimately commit to and actually implement any given change, the entire group cannot successfully fashion, guide, and lead the change. The group as a whole must trust these leaders, and they must have the support of the entire group to enact real change.

For our calculus re-envisioning project, the leaders were long-serving, tenured members of their programs with genuine influence, earned trust, and leadership experience. The ACS grant program helped us meet each other and discover our mutual interests in addressing the problems in the calculus sequence highlighted above. The cross-institutional collaboration with faculty at another similar university proved incredibly helpful and useful. The conversations were much richer when more people were in the room with diverse perspective, experiences, and needs. The commonality of concerns was reassuring and we were able to make important progress through our cross-institutional dialogue. And more than concerns, our conversations helped us recognize new opportunities, develop clearer insights, and identify stronger solutions.

This guiding coalition has taken the lead on gathering data and resources, and sharing this information with the program as whole in an effort to develop a corporate sense of urgency. We shared multiple draft versions of re-sequencing ideas with our entire programs and listened, taking their responses back into the coalition for further discussion and refinement. Throughout the design and implementation process, we have guided and advocated for actual change. Finally, our departments are relatively small (10 math faculty members at Centre College and 6 math faculty members at Southwestern University) and so, at times, this whole group became something of a guiding coalition as we built consensus on this change effort. That being said, our central group of three faculty has remained the overall leaders and guides throughout the process.

3) Developing a Vision and Strategy

Curricular change involves understanding the status quo, examining this status quo with a critical (while still generous) eye toward identifying both strengths and weaknesses, exploring options for pursuing opportunities for further strength while also shoring up weaknesses, and choosing a path for moving forward. This path forward must be attentive to personnel as we ask folks to adapt ways of working and the content of what they teach. Faculty are often deeply invested in what they already do and hold that work in some sense "close to their hearts". In addition, designing curriculum involves making choices among many competing goods: whether to include one topic versus another, how deeply to address each topic, how to scaffold topics within a course and/or across multiple courses. Other questions needing attention include how best to enable student learning of these topics and what skills need to be developed alongside this content knowledge.

Developing a vision for curricular change also requires finding that key idea or cluster of ideas that will lie at the heart of the change. These ideas can be developed from many sources: examining data, engaging national-level conversations, reading curricular guidelines and recommendations, and offering our own personnel or departmental insights. And they may (and probably will) evolve over time through a dynamic process of critical examination and active dialogue with a broader audience and perhaps piloting trial versions of particular courses. However, having some initial, starting point is essential, as just change for the sake of change is usually not compelling nor helpful.

Alongside this vision, the guiding coalition needs to develop a strategy for initiating, leading, and following through on the overall change process. They need to decide how to tell the story of why change needs to happen in a compelling fashion, and multiple versions of that story might be needed so as to best appeal to the stakeholders in the various audiences of the administration, the faculty in your own department, faculty in impacted departments, current students, prospective students, and others. The leaders need to accurately identify the resources required for pursuing change, with attention to finances and time, and in the context of available resources. Similarly, they should aspire to identify a reasonable timeline for introducing, developing, implementing, and assessing a curricular change. In all this aspirational planning, they need to wrestle with the tension between the desired ideal and worst case scenarios, as well as keep in mind how different our colleagues' perspectives might be in both expected and surprising ways.

For our particular efforts in re-envisioning calculus, our vision was informed by national curricular guides, models from aspirant institutions, and a group consensus on developing a fresh, modern take on calculus and its application to understanding the real world that would be both accessible and appealing to our current students. Our strategy for working toward implementing this aspirational vision involved:

- gathering data and resources indicating the need for change (see Appendix A),
- sharing this information with our colleagues and leading some initial conversations about these calls to action from the data and national organizations,

- creating a collection of curricular models in response to this information and our conversations with each other and our colleagues,
- conducting a two-day summer workshop with most colleagues from both departments to settle on guiding principles, discuss and refine models, and develop particular skills connected to this potential change effort,
- taking a break during the remainder of the summer to let folks reflect on these ideas on their own and rest from the positive, but still intense conversations around this curricular change, and
- beginning the new academic year with renewed efforts that included: revisiting the curricular models within the department; engaging in cross-departmental conversations with other programs that would be influenced by a change; initially addressing logistical issues with placement, transfer credit and more; affirming a corporate commitment to implementing a particular new model; establishing a timeline for implementation; and identifying working groups to develop each of the three courses in the sequence.

Looking toward the future, more work needs to be done in the actual implementation process and the follow up assessment process.

4) Communicating the Change Vision

The guiding coalition needs to decide how to tell the story of why change needs to happen in a compelling fashion. Multiple versions of that story will likely be needed so as to best appeal to the stakeholders in the various audiences from among the administration, the faculty in your own department as well as in impacted departments, current students, prospective students, and others. Sources of information for telling this story include local and national data on student performance and outcomes, ideas from national-level conversations, curricular guidelines and recommendations form national organizations, and ideas from your own personnel or from departmental insights and experiences.

Similarly, the guiding coalition needs to decide the actual process for sharing this story with each of these diverse audiences. For your own department, face-to-face, dedicated meeting time to present and talk about these ideas are important for initial conversations, accompanied by annotated print and online resources for additional study. Further conversations will likely be needed to overcome the inertia of the status quo, based on the scale of the curricular revision. In addition, bringing in an outside, well-respected person from another institution might be helpful for enabling genuine communication and engagement with the change ideas. Sometimes we listen better to someone new than to those we work with all the time, and we might be more willing to actively engage in the change process. On a related note, face-to-face meetings with other impacted programs are important and these might require active dialogue to understand what they actually need from a prerequisite course within your department.

Finally, folks need to be reminded of this compelling story sharing the vision along the way. When we're down in the weeds working through the details, remembering why we're engaged

in this process of change can enable substantive change and strengthen the quality and character of that change.

5) Empowering Broad-based Action

Substantive curricular change can involve multiple constituencies who must have a voice in the design and implementation of the curriculum. Faculty are in charge of the curriculum and often have strong opinions about the courses they teach in particular and, in some cases, about the courses their colleagues teach, because of prerequisite dependencies and/or their aspirations for their majors. Bringing multiple, diverse perspectives into the conversation is also enriching and multiple academic studies have verified higher quality outcomes result from pursuing and welcoming diverse voices. In the sometimes politicized environments of academic departments with skewed power differentials, ensuring an inclusive conversation that not only welcomes, but also actively seeks, all voices requires intentional attention to ensuring participation and engagement.

For substantive curricular change, multiple meetings must be dedicated to this endeavor and perhaps a multi-day workshop or two might be needed as well. At some point, all stakeholders should have an opportunity to be involved, but smaller working groups might be appropriate along the way, as might sending individuals and/or small groups to conferences and workshops offered by national organizations. After these learning and working opportunities, participants should be provided means for sharing the insights they garnered from these experiences.

In our calculus re-envisioning project, we invested multiple meetings discussing these ideas with all members of our departments, which are small enough to bring everyone together on a frequent enough basis to move forward in active dialogue while providing time between meetings for reflection about what had been discussed. In addition, as mentioned above, we held a joint, two-day workshop during the summer to provide both an opportunity for an extended, focused dialogue with members of our own departments enriched by cross-institutional conversation. We found the following structure to be quite helpful.

- **Day 1 Morning**: Bring in an outside speaker with experience in re-envisioning and resequencing similar courses at their own institution. It is best if this person teaches at an institution similar to your own. Let this person guide the discussion and reflect on his/her own experiences. Topics that could be covered include: their motivation, the logistics of what their new curriculum looks like, and their process of developing these courses and implementing their change. The discussion might include identifying points of similarity and difference between their work and your own context, as well as addressing how it might be relevant for furthering your own distinct vision.
- **Day 1 Afternoon**: If the new sequence incorporates technology that is new for some of your faculty, include an afternoon session on learning how to use that technology and thinking about how to incorporate its use into your courses.
- **Day 2 Morning**: While your speaker could stay to watch and be a part of the discussion, this second day really should be focused on your own work as a department to make progress

toward what your new sequence might include. A great starting point is to agree on a set of guiding principles against which you test your curricular ideas and make choices among the many competing goods available for any course of study. The next section provides the set of guiding principles that we agreed upon during our calculus project; these might be transferable to your context, or you may have other guiding principles you want to include (or some you want to exclude). A fundamentally important goal is to make sure that everyone agrees on these guiding principles before moving on as they will play a pivotal role in making later decisions. Seeking everyone's input is vital. Silent nonparticipation is not helpful and cannot be interpreted as expressing dissent (nor assent) in these important discussions.

- **Day 2 Afternoon**: After agreeing on guiding principles, begin developing and examining more of the details for the curricular change. One approach is to start with some proposed models (from other institutions or based on ideas members of your own faculty). Alternatively, you could start with a list of topics and start rearranging them in small groups for three to four faculty; we worked with literal slips of paper listing topics in groups of three to four faculty members intentionally blended across institutions. Every 30-45 minutes have the small groups report back to the whole group on their progress and their points of struggle. A goal by the end of the afternoon is to have one or two specific examples of curricular models that can be taken forward for further discussion during the coming months.

Even after such a workshop, much work will most likely remain to be done and the active participation of all stake holders should be solicited in this process. The process of discussing reasons to change, hosting a workshop, creating some new sequences, voting on a final product, and establishing a detailed plan for moving forward will likely take the equivalent of a full calendar year.

6) Generating Short-Term Wins

Taking a full year to develop a plan will likely be followed by multiple years for developing, piloting, and modifying the new courses and curriculum. For such a multi-year process, having some short-termer successes along the way is vital for sustaining momentum and progress toward a successful, new, fully-implemented curriculum. Examples of such successes include the group:

- committing to exploring change,
- reaching consensus around a set of guiding principles,
- voting to approve a particular curricular change,
- identifying a timeline for implementation,
- sorting through logistical details for such topics as placement, sequencing, transfer and/or AP credit, and
- piloting each course or component of a course involved in the curricular change.

An example of one such short-term win from our calculus re-envisioning project is the collection of guiding principles developed by our groups during our two-day summer workshop. These principles were generated as a way to determine how topics would be placed, what topics would be taken away, and what topics might be added. In other words, when we have to make a choice among competing goods, we will come back to these principles as a means to inform and guide our decisions. For our re-envisioned sequence of calculus courses, we agreed upon the following eight guiding principles:

1. The courses are organized in a way that engage all students and promote educational equality.
2. Based on a student's background, every course could be a good entry point into the sequence. Based on student interest, each course could be a good exit point from the sequence.
3. There is a smooth increase in difficulty across the sequence.
4. Some concepts and applications are intentionally layered in the sequence.
5. Every course incorporates activities where students utilize technology to further engage with the material.
6. Multiple perspectives are used to investigate topics. In the Calculus sequence, this includes differing perspectives such as numerical/analytical, discrete/continuous, and theory/application.
7. Every course has a persistent emphasis on multidisciplinary interactions.
8. Every course incorporates some theoretical disciplinary thinking.

Such a list of guiding principles must be specific to the particular faculty, students, and institutional context, and we can certainly envision some groups identifying quite different sets of guiding principles that are best suited to their context.

In any case, the important aspect of this set of guiding principles is that they represented an important short-term win for our groups. We reached a consensus about what principles were most important to us: offering our ideas, corporately editing them, making compromises, and ultimately agreeing to let these principles serve as our guides. And reaching this consensus was hard work, requiring intense effort and personal investment. The moment of group affirmation of this list was an uplifting, celebratory, and invigorating, enabling our further progress in the next steps of our curriculum change process.

7) Consolidating Gains and Producing More Change

This aspect of the change process has both short-term and long-term components. At each step along the way, we remind folks about and affirm the decisions just made, and we refer back to our past commitments as we look to moving forward. These affirmations serve to solidify the group decisions that have already been made in the culture and serve as spring boards for further discussions.

After each meeting and workshop, a summary of the decisions made about broad principles and particular details is circulated to all participants. A list of open topics for further discussion

is also maintained by the leaders in the guiding coalition along the way to ensure that important ideas and topics are not overlooked or forgotten.

8) Anchoring New Approaches in the Culture

Curricular changes can be readily embedded in the written documentation of an academic program, but embedding the reality of these changes in the actual teaching implementation of the corresponding courses by every instructor teaching these courses requires more work. An inclusive process that welcomes and actively seeks contributions from all stakeholders is a vital component of ensuring the aspired to change actually happens and becomes a stable component of the curriculum. The initial piloting of courses should be undertaken by strong teachers who are enthusiastic proponents for the change, and should be afforded the time and resources needed to carry out their developmental work leading up to first offerings. And these pilot offerings will likely involve some missteps, a reality that should be acknowledged and accepted as a natural component of all change efforts. After a first go, the curricular change should be re-examined and course corrections made to obtain greater success toward satisfying the guiding principles and bringing the sought-for curricular vision into reality.

Some Last Thoughts

Any curriculum change effort requires a substantive investment of time, energy, and other precious resources from all constituents involved in the project. Having an overall vision for the entirety of the process and the stages involved in making major change will support and promote the ultimate success of the change. Ultimately, the goal of our educational endeavors is to enable learning by our students so they can become viable, informed citizens and pursue their particular life aspirations. Our world is constantly changing in all its many dimensions, our students are constantly changing, and we are constantly changing. And so, our courses, our approaches to teaching, the skills and ideas we teach, and our overall curricula must also change to better meet the needs and aspirations of our students and society.

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Appendix A: Publications Highlighting the need for Re-envisioning Calculus

Substantive Publications from National Organizations with some annotations

1) A Common Vision Project - 2015
   - MAA Website about the project: https://www.maa.org/programs-and-communities/curriculum%20resources/common-vision
   - PDF of 73 page full report: https://www.maa.org/sites/default/files/pdf/CommonVisionFinal.pdf
   - The first three paragraphs of the Executive Summary highlight the sources and scope of this project and states a compelling, recurrent theme:

     The *Common Vision* project brought together leaders from five professional associations — the American Mathematical Association of Two-Year Colleges (AMATYC), the American Mathematical Society (AMS), the American Statistical Association (ASA), the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM) — to collectively reconsider undergraduate curricula and ways to improve education in the mathematical sciences. Project participants represented not only these mathematical sciences associations, but also partner STEM disciplines, higher education advocacy organizations, and industry.

     We began with an in-depth examination of seven curricular guides published by these five associations and spent a substantial amount of time identifying common themes in the guides. This report reflects a synthesis of these themes with our own research and input from project participants and other thought leaders in our community.

     One of the most striking findings is that all seven guides emphasized this point, in particular:

     The status quo is unacceptable.

     Consequently, this report focuses on specific areas that require significant further action from the mathematical sciences community to improve undergraduate learning, especially in courses typically taken in the first two years. These areas fall into one of four categories: curricula, course structure, workforce preparation, and faculty development.

2) MAA National Studies of College Calculus – 2015 and ongoing
   - Insights and Recommendations from the MAA National Study of College Calculus (2015) PDF of 169 page full report: https://www.maa.org/sites/default/files/pdf/cspcc/InsightsandRecommendations.pdf

3) Joint Publication of MAA and NCTM: The Role of Calculus in the Transition From High School to College Mathematics - 2017
   - PDF of 83 page full report: https://www.maa.org/sites/default/files/RoleOfCalc_rev.pdf
   - The very end of the report includes three recommendations, the first two from a 1986 MAA-NCTM joint statement about this topic and a new third recommendation

Recommendation 3: The college curriculum should acknowledge the ubiquity of calculus in secondary school, shape the college calculus curriculum so that it is appropriate for those who have experienced introductory calculus in high school, and offer alternatives to calculus.

Colleges and universities can no longer pretend that they can teach calculus the same way that they did in 1990. First of all, the students who twenty years ago made up the top third of the students in Calculus I now skip this course when they enter college. Second, most students enter college calculus already familiar with many of the standard techniques and procedures and a strong preconception of what this course is about and what is required in order to succeed. They are primed to ignore the conceptual development of the subject. Third, the push to accelerate high school students means that many of these students enter college with a weaker mathematical foundation than they would have had a generation ago. And finally, revisiting material they have already studied is not an effective means of engaging students and building a desire to learn mathematics. There are many ways of handling these problems. One is to make it clear that this is not their high school calculus class, either by taking a modeling approach that focuses on differential equations or going to the other extreme and making this an introductory course in analysis. One also can start students with a course that is not calculus, such as discrete mathematics or linear algebra.

Conclusion

The United States has fallen into a seriously dysfunctional system for preparing students for careers in science and engineering, guaranteeing that all but the very best rush through essential parts of the mathematics curriculum and then are forced to sit and spin their wheels while they try to compensate for what was missed. It will take time and work by all involved to repair the transition from high school to college. We cannot afford to wait.

Additional Online and Print Articles

1) Focus of MAA at https://www.maa.org/press/periodicals/maa-focus
   - April/May 2018 – Stem Inclusion Study by Pearson and Jensen-Vallin
   - October/November 2017 – Math Circles Embrace Underserved Students by Long et al
   - August/September 2017 – An Alternative Calculus Sequencing by Dungan and Boucher
   - April/May 2017 – Not Yet Ready for Calculus by Doree and Hartzler
   - April/May 2017 –Let's Do It: Using Modeling in the Classroom by Winkel
   - February/March 2017 – Diverging from the Standard Fare: Variations in the Calculus Curriculum by Voigt, Apkarian, and Rasmussen
   - October/November 2016 – New Directions for the Calculus Track by Axtell, Doree, Dray
   - August/September 2016 – Combating Education Inequity: MAA Distinguished Lecture
2) Launchings by David Bressoud at http://launchings.blogspot.com/
   - May 1, 2018: Trends in Mathematics Majors

- January 1, 2018: Indicators for STEM Education
- August 1, 2017: Changing Demographics
- June 1, 2017: Re-imagining the Calculus Curriculum, II
- May 1, 2017: Re-imagining the Calculus Curriculum, I
- February 1, 2017: MAA Calculus Study: PtC (Persistent through Calculus) Survey Results
- October 1, 2016: MAA Calculus Study: Women in STEM
- December 1, 2015: Strategies for Change
- September 1, 2015: Calculus at Crisis V: Networks of Support
- August 1, 2015: Calculus at Crisis IV: Best Practices
- July 1, 2015: Calculus at Crisis III: The Client Disciplines
- June 1, 2015: Calculus at Crisis II: The Rush to Calculus
- May 1, 2015: Calculus at Crisis I: The Pressures

3) 2017 Resequencing Calculus by Dwyer et al at https://www.tandfonline.com/doi/full/10.1080/10511970.2017.1333179
4) 2017 Reconsidering STEM Faculty Professional Development: Daring Approaches to Broadening Participation in Stem by Kelly Mack at https://www.aacu.org/diversitydemocracy/2017/fall/mack
5) 2016 Improving Calculus II and III through the Redistribution of Topics by George et al at https://www.tandfonline.com/doi/pdf/10.1080/10511970.2015.1094685
6) 2016 Beyond a Deficit View by Byron White at https://www.insidehighered.com/views/2016/04/19/importance-viewing-minority-low-income-and-first-generation-students-assets-essay
7) 2016 Improving Underrepresented Student Persistence in STEM by Mica Estrada, et al at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5008901/
8) 2015 Increasing Persistence in Undergraduate Science Majors: A Model for Institutional Support of Underrepresented Students by Toven-Lindsey, et al at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4477728/
9) 2012 Mindsets that Promote Resilience: When Students Believe that Personal Characteristics can be Developed by Yeager and Dweck at https://www.researchgate.net/publication/262908828_Mindsets_that_promote_resilience_When_students_believe_that_personal_characteristics_can_be_developed
10) 2011 Women in STEM: A Gender Gap to Innovation by Beede et al at http://www.esa.doc.gov/sites/default/files/womeninstemagaptoinnovation8311.pdf
11) 2010 Reducing the Gender Achievement Gap in College Science: A Classroom Study of Values Affirmation by Miyake et al at https://www.colorado.edu/ftep/sites/default/files/attached-files/miyake_-_gender_achievement_gap.pdf
12) 2006 Reducing the Racial Achievement Gap: A Social-Psychological Intervention by Cohen et al at http://msan.wceruw.org/documents/resources_for_educators/Race/Cohen%20et%20al%202006.pdf