A vanguard of math instructors is embracing ideas developed by two Stanford professors to reform math instruction. Their approach includes more visual and creative exercises, discussions of ideas and procedures rather than a focus on memorization and speed, and individually tailored lessons.

*San Jose Mercury News, March 18, 2015*
Crazy for Calculus
DKDC
Outline

- Developmental Mathematics Revision
- Interesting Research
- Classroom Culture
- Student Risk Factors & Faculty Practices, Values, Attitudes
- Learning as a Performance
- Integrating What We Know
- Responses
Developmental Mathematics Revisions

Curriculum
- Real World Problems, Project-based, Reduced

Delivery Method
- Accelerated
- Modularized (decelerated)
- Computerized
- Supplemental Instruction

Basic Skills
- Come to class, on time, pay attention, take notes, do your homework
Modest Successes

- Modest success is good
- MathAMATYC Educator – February 2015
  - College Algebra Redesign (10% increase)
  - Computer-Based Instruction (no difference)
  - Supplemental Instruction (no difference)
- MDRC report (little or no improvement)
- LaGuardia CC (substantial improvement)
  - $14,000 per student
Interesting Research

- Carol Dweck on Mindset
  - Growth vs Fixed Mindset

- Jo Boaler on Brain Malleability

- James Stigler on Culture
  - Productive struggle
  - Explicit connections
  - Deliberate practice

- Learning as a Process

- Learning as a Performance (Theory of Performance)
The Usual Suspects

- Active Learning
- Student Centered
- Technology
  - Presentation software
  - Graded homework software
  - Testing software (placement and grading)
  - Mathematical software (calculators and computers)
Student Risk Factors

Risk factors are issues, characteristics or circumstances that may cause students to dropout or fail academically.
What We Can Do to Help Students

Student Risk Factors Related to 4 Areas
- Perseverance
- Academic Mindset
- Learning Strategies
- Social Skills

20 Critical Risk Factor
- Other risk factors exist
Perseverance

- Lacks self-discipline
- Procrastinates
- Irresponsible
- Afraid of failure
- No sense of self-efficacy
- Financial/Time Constraints
Academic Mindset

- Unmotivated
- Aimless (No clear direction/goals)
- 1st Generation College Student
- Fixed mindset
Learning Strategies

- Teacher pleaser
- Unchallenged (bored)
- Memorizes instead of thinking
- Does not transfer/generate knowledge
- Highly judgmental/negative about themselves
- Minimal metacognitive awareness
Social Skills

- Non-team player
- Insecure public speaker
- Lacks a support system
- Lacks mentors/Role models
Things to Consider Not Doing
Dimensions of a Culture of Success

1. Challenge
2. Cognitive Complexity
3. Control
4. Delivery
5. Design
6. Efficacy
7. Feedback
8. Measurement
9. Ownership
10. Relationship
11. Self-Awareness
12. Scope of Learning
13. Social Orientation
14. Transparency
<table>
<thead>
<tr>
<th>Aspect</th>
<th>Descriptor and Focus</th>
<th>Faculty Mindset</th>
<th>Common Values, Attitudes, and Practices</th>
<th>Student Mindset</th>
<th>Risk Factor Elevated</th>
</tr>
</thead>
</table>
| Complexity   | Memorizing - Present a large body of information | "I have all this required content that I must cover during this course for future courses" | • Content rich courses have over 100 learning objectives/competencies that must be covered  
  • Multiple choice exams are the most efficient means to measure learning with large sections  
  or with extensive information  
  • Must limit the number of challenging or complex questions due to lack of time | "I must memorize all of this information so that I recall it for the quizzes, exams, assignments, and essays." | Memorizers |
| Complexity   | Memorizing - Practice lots of problems | "If I challenge learners to really understand at higher levels (problem solving), they would fail the class" | • Teachers test in areas where students have had lots of homework and practice solving problems  
  • Teachers provide a couple of challenging test problems to identify the "A" students  
  • Teachers limit class time to work on open-ended problems because too much content | "It is unfair to put problems on tests that were not presented in class, on homework assignments, or covered in review sessions" | Unchallenged |
| Control      | Teacher Centered - Exert Authority | "I know what I want students to learn and I exert my will on them in that direction" | • Teachers will not change dates for exams or provide make up exams in any situation  
  • Teachers decide what is important to learn and when and how it will be graded  
  • Teachers make decisions in the class because they know best what will help the students | "Since faculty have all the control and demand respect, just give them exactly what they want in the way they want it" | Deferential |
| Control      | Teacher Centered - Defines the rules | "I want students to follow my rules and do what I ask so they will be successful" | • Teachers define what it means to attend class and participate  
  • Teachers want to see work products done in a specific way (format)  
  • Teachers will have a set of class conventions that must be followed else there will be consequences | "I don't really care what happens with my grade if I can't do what I want to do or do it in the way I want to do it." | Irresponsible |
<table>
<thead>
<tr>
<th>Aspect</th>
<th>Descriptor and Focus</th>
<th>Faculty Mindset</th>
<th>Common Values, Attitudes, and Practices</th>
<th>Student Mindset</th>
<th>Risk Factor Elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Memorizing - Present a large body of information</td>
<td>&quot;I have all this required content that I must cover during this course for future courses&quot;</td>
<td>- Content rich courses have over 100 learning objectives/competencies that must be covered&lt;br&gt;- Multiple choice exams are the most efficient means to measure learning with large sections or with extensive information&lt;br&gt;- Must limit the number of challenging or complex questions due to lack of time</td>
<td>&quot;I must memorize all of this information so that I recall it for the quizzes, exams, assignments, and essays.&quot;</td>
<td>Memorizers</td>
</tr>
<tr>
<td>Complexity</td>
<td>Memorizing - Practice lots of problems</td>
<td>&quot;If I challenge learners to really understand at higher levels (problem solving), they would fail the class&quot;</td>
<td>- Teachers test in areas where students have had lots of homework and practice solving problems&lt;br&gt;- Teachers provide a couple of challenging test problems to identify the &quot;A&quot; students&lt;br&gt;- Teachers limit class time to work on open-ended problems because too much content</td>
<td>&quot;It is unfair to put problems on tests that were not presented in class, on homework assignments, or covered in review sessions&quot;</td>
<td>Unchallenged</td>
</tr>
<tr>
<td>Control</td>
<td>Teacher Centered - Exert Authority</td>
<td>&quot;I know what I want students to learn and I exert my will on them in that direction&quot;</td>
<td>- Teachers will not change dates for exams or provide make up exams in any situation&lt;br&gt;- Teachers decide what is important to learn and when and how it will be graded&lt;br&gt;- Teachers make decisions in the class because they know best what will help the students</td>
<td>&quot;Since faculty have all the control and demand respect, just give them exactly what they want in the way they want it&quot;</td>
<td>Deferential</td>
</tr>
<tr>
<td>Control</td>
<td>Teacher Centered - Defines the rules</td>
<td>&quot;I want students to follow my rules and do what I ask so they will be successful&quot;</td>
<td>- Teachers define what it means to attend class and participate&lt;br&gt;- Teachers want to see work products done in a specific way (format)&lt;br&gt;- Teachers will have a set of class conventions that must be followed else there will be consequences</td>
<td>&quot;I don't really care what happens with my grade if I can't do what I want to do or do it in the way I want to do it.&quot;</td>
<td>Irresponsible</td>
</tr>
</tbody>
</table>
| Delivery | Presentation - share expertise | "I share my extensive disciplinary expertise with the students" | Teachers tell students what they will teach them, teach them, and tell them what they have been taught  
Teachers explain complex ideas so students can understand them  
Teachers create PowerPoint slides as a key resource for the students during class and for review later when studying | "I must capture all of this information because this is what will be on the test" | Transcribers |
|----------|-------------------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------|-----------|
| Design   | Rigid - teach to the test     | "I will provide all examples of how to do the types of problems before they take the exams." | Teachers provide sample exam problems in lecture and review sessions that closely match the exam problems  
Teachers assign a lot of practice problems for homework  
Teachers and colleges find it unfair to have students try to solve exam problems in a new context | "I need to remember exactly how to solve each of the types of problems shown and practiced" | Lack of transferability |
| Feedback | Evaluation - of people        | "I must constantly point out where students are weak so they can get better." | Mark up homework and quizzes to show students' deficiencies that need work  
Place comments on essays of what needs to be fixed in their thinking and communication skills  
Grade down based on mistakes, errors, and missing the point on exams | "I constantly worry about how well I have done, what teachers think of me, if am I doing good, and should I be worried about the future" | Self-evaluators |
| Self-Awareness | In the moment – doing | "As I can get the student to work harder, I can make them more successful." | Faculty assigns lots of homework practice problems  
Having students write lots of academic papers to illustrate knowledge  
Faculty takes attendance | "If I go to class, do the homework, and give the faculty what they want on papers and tests, I will get my degree." | Aimless |
Learning as a Performance

Theory of Performance

- Identity
- Skills
- Knowledge
- Contexts
- Personal factors
- Fixed factors
15 Mathematical Learning Skills

- Recognizing patterns – perceiving consistent repetitive occurrences
- Using prior knowledge – integrating unprompted knowledge
- Validating – using alternative methods to test results
- Recalling – retrieving from memory
- Transferring – using ideas in a new context
15 Mathematical Learning Skills

- Recognizing patterns – perceiving consistent repetitive occurrences
- Using prior knowledge – integrating unprompted knowledge
- Validating – using alternative methods to test results
- Recalling – retrieving from memory
- Transferring – using ideas in a new context
Learning Skills for Mathematics

- Analogizing – representing similar elements in dissimilar contexts
- Generalizing – transferring knowledge to multiple contexts
- Quantifying – representing with nos. or eqns.
- Diagramming – clarifying relationships through visual representation
- Recognizing the problem – stating what is wrong or missing
Learning Skills for Mathematics

- Defining the problem – articulating a problem and need for solution
- Establishing requirements – articulating solution criteria
- Subdividing – separating into sub-problems
- Generalizing solutions – modifying solutions for broader applicability
- Analyzing – (characterizing individual parts)
  Identifying similarities, Identifying differences, Identifying assumptions, Inquiring, Exploring context
<table>
<thead>
<tr>
<th>Aspects of a Culture of Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Challenge</td>
</tr>
<tr>
<td>2. Cognitive Complexity</td>
</tr>
<tr>
<td>3. Control</td>
</tr>
<tr>
<td>4. Delivery</td>
</tr>
<tr>
<td>5. Design</td>
</tr>
<tr>
<td>6. Efficacy</td>
</tr>
<tr>
<td>7. Feedback</td>
</tr>
<tr>
<td>8. Measurement</td>
</tr>
<tr>
<td>9. Ownership</td>
</tr>
<tr>
<td>10. Relationship</td>
</tr>
<tr>
<td>11. Self-Awareness</td>
</tr>
<tr>
<td>12. Scope of Learning</td>
</tr>
<tr>
<td>13. Social Orientation</td>
</tr>
<tr>
<td>14. Transparency</td>
</tr>
<tr>
<td><strong>Traditional</strong></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>In a typical college classroom</td>
</tr>
<tr>
<td>Students come in with little preparation and instructors explain or present concepts from the textbook using carefully crafted lectures which some students write notes and try to memorize</td>
</tr>
<tr>
<td>Instructors model application of concepts at the board to the whole class</td>
</tr>
<tr>
<td>Instructors ask a few questions to the whole class during the lecture which are answered by a few students with students writing down answers</td>
</tr>
<tr>
<td>Instructor reviews the homework by working the harder problems from the homework in front of the whole class</td>
</tr>
<tr>
<td>Instructors assign numerous problems from the textbook or homework software</td>
</tr>
<tr>
<td>Feedback</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Review sessions are run by the instructor walking through questions presented by individual students</td>
</tr>
<tr>
<td>The evaluation of student performance includes giving students partial credit for incomplete solutions</td>
</tr>
<tr>
<td>Instructors work problems pointing out problems that present important issues</td>
</tr>
<tr>
<td>Minimal learning community and extensive individual work in a very evaluation culture</td>
</tr>
</tbody>
</table>
Integrating What We Know

What kinds of curricula?
What experiences do students need?
  – Boot camp: Learning How to Learn Mathematics
  – Learning How to Learn Mathematics courses
What experiences do instructors need?
  – Faculty members
  – Adjunct faculty members
  – Graduate Teaching Assistants
What campus-wide support is needed?
Responses
References


