IMPROVING FIRST YEAR STEM RETENTION THROUGH MATHEMATICS PLACEMENT, LEARNING COMMUNITIES AND GROWTH MINDSET

Tracy Bradley Maples, Acting Associate Dean, College of Engineering
Krzysztof Slowinski, Associate Dean, College of Natural Sciences and Mathematics
• 2650 students
  - 2246 undergraduate
  - 404 graduate
• 7 Departments
• 21 Degree Programs

http://web.csulb.edu/colleges/cnsm/

• 4716 students
  - 3917 undergraduate
  - 799 graduate
• 6 Departments
• 20 Degree Programs
• Joint PhD with Claremont Graduate School

http://web.csulb.edu/colleges/coe/
First we discuss:

- Institutional Context
- Inclusive Excellence and Graduation Rates
CSULB is committed to serving the people of California and endeavors to provide academic programs and campus services for both traditional and non–traditional students. The university enrolls students who have graduated in the top third of the state’s high school graduating class, those who have completed a community college program and adults re–entering education.
The Social Mobility Index (SMI)

- SMI measures the extent to which a college or university educates more economically disadvantaged students (with family incomes below the national medium) at lower tuition so that they can graduate and obtain good paying jobs.

- SMI computed from five variables:
  - Published tuition
  - % of student body whose families are below the US median income
  - Graduation rate
  - Reported median salary 0-5 years after graduation
  - Endowment

http://www.socialmobilityindex.org/
GRADUATION RATES VS. NATIONAL PEERS

http://blog.numbersbox.com/p/college-comparison.html
STEM VS. CAMPUS GRADUATION RATES

2008 FTF STEM COHORT 6Y GRADUATION RATES VS. SAT

IN STEM | IN ANY MAJOR | Expon. (IN STEM) | Expon. (IN ANY MAJOR)
CAMPUS-WIDE IMPACTION
MANDATORY
“DECLARATION REQUIREMENTS”

FOCUS ON TIME TO DEGREE
MANDATORY
“DEGREE PROGRESS RULES”

IMPORTANT CONSIDERATIONS

CALC 1
AND CHEMISTRY
GPA >2.5
BY 60 UNITS

CALC 1
BY END OF
FIRST YEAR
What is required to be a national model of inclusive excellence?

“The new paradigm must focus on institutional assessment, action, and accountability, with individual and shared responsibility deeply embedded as priorities, in contrast to the old paradigm, which depends on the assumption that student achievement gaps are rooted in students’ deficits. In the new paradigm, campus educators understand and value the assets that students bring to educational experiences, as well as the importance of institutional change and continuous improvement to better meet the needs of everyone involved in our learning community.”

President Jane Close Conoley
GROWTH MINDSET

ASSESSMENT OF NON-COGNITIVE ACADEMIC SKILLS — TARGETED MINDSET INTERVENTIONS
http://web.csulb.edu/colleges/cnsm/advising/howtosucceed.html

ALEKS PPL
Calculus Placement

CALCULUS SEQUENCE and GENERAL CHEMISTRY REDESIGNED
Redesigned via CSU CO Course Redesign with Technology Promising Practices

COE BEACH ENGINEERING STUDENT SUCCESS (BE SST) LEARNING COMMUNITY
2 sections@ 25 students, math / Eng. Comp. / ENGR 101 & 103 / supplemental instruction / tutoring
Fall 2014 Pilot: 95% Calculus pass rate, 18 of 22 students earning above a 3.0 GPA

ENGR 101 — Intro to Eng Profession
ENGR 102 — Academic Success Skills

CNSM Science Safari and Math and Science Orientation

CNSM FRESHMAN LEARNING COMMUNITIES
6 sections @ 26 students, Math. / Chem. / NSCI 190A / supplemental instruction / peer mentoring support
Fall 2015 Pilot: “full completion” rate went from 45% to 70%

NSCI 190A — Learning Strategies
NSCI 190BA — Research Lab Shadowing

SOAR ADVISING

MANDATORY FRESHMAN ADVISING
Intrusive Advising Interventions (Pretest / Early Warning / GPA Interventions)
The concept of a **growth mindset** was developed by psychologist Carol Dweck and popularized in her book, *Mindset: The New Psychology of Success*.

A **mindset**, according to Dweck, is a self-perception or “self-theory” that people hold about themselves.

**What Kind of Mindset Do You Have?**

**Growth Mindset**
- I can learn anything I want to.
- When I'm frustrated, I persevere.
- I want to challenge myself.
- When I fail, I learn.
- Tell me I try hard.
- If you succeed, I'm inspired.
- My effort and attitude determine everything.

**Fixed Mindset**
- I'm either good at it, or I'm not.
- When I'm frustrated, I give up.
- I don't like to be challenged.
- When I fail, I'm no good.
- Tell me I'm smart.
- If you succeed, I feel threatened.
- My abilities determine everything.

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**A SOCIAL COGNITIVE APPROACH TO MOTIVATION AND PERSONALITY**

By: DWECK, CS; LEGGETT, EL

**PSYCHOLOGICAL REVIEW** Volume: 95 Issue: 2 Pages: 256-273 Published: APR 1988

**Times Cited:** 2,584
*(from Web of Science Core Collection)*
A Mindset Shift

Fixed

- Avoid challenges
- Give up easily
- See effort as pointless
- Ignore useful negative feedback
- Feel threatened by the success of others

Growth

- Embrace challenges
- Persist in the face of setbacks
- See efforts as a path to mastery
- Learn from criticism
- Feel lessons and inspiration in the successes of others.

Consider where you would place yourself currently. Now think about what you can do to release your growth mindset.
### Key principle: neuroplasticity

<table>
<thead>
<tr>
<th></th>
<th>Fixed Mindset</th>
<th>Growth Mindset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal in School?</td>
<td>Look Smart</td>
<td>Learn</td>
</tr>
<tr>
<td>Values effort?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Reaction to Failure?</td>
<td>Give Up</td>
<td>Work Harder</td>
</tr>
<tr>
<td>Achievement</td>
<td>Lower</td>
<td>Higher</td>
</tr>
</tbody>
</table>

https://survey.perts.net/
Growth Mindset
Do I have what it takes?

Belonging
Uncertainty
Do I really belong here?

STEREOTYPE THREAT AND THE INTELLECTUAL TEST-PERFORMANCE OF AFRICAN-AMERICANS
By: STEELE, CM; ARONSON, J
JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY Volume: 69 Issue: 5 Pages: 797-811 Published: NOV 1995

Times Cited: 2,119
(from Web of Science Core Collection)
Mind-set interventions

Typically, short exercises / assignments / reflections:

“Can I learn and grow my intelligence?”

J. Aronson and his colleagues (2002) taught a growth mind-set to college students in three 1-hr laboratory sessions and then encouraged students to internalize this message by teaching it to struggling middle school students. This experience raised the college students’ semester grade point averages (GPAs).

Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence
By: Aronson, J; Fried, CB; Good, C
JOURNAL OF EXPERIMENTAL SOCIAL PSYCHOLOGY Volume: 38 Issue: 2 Pages: 113-125 Published: MAR 2002

Times Cited: 317
(from Web of Science Core Collection)
Pre-matriculation lay theory interventions narrow first-year achievement gaps when delivered to entire incoming classes.

David S. Yeager et al. PNAS 2016;113:E3341-E3348
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  - Intrusive Advising Interventions (Pretest / Early Warning / GPA Interventions)

SUMMER FALL SPRING
WORKSHOP ON CREATING AND FOSTERING A GROWTH-MINDED CLASSROOM

Jen-Mei Chang, Jason Schwans, Krzysztof Slowinski
College of Natural Sciences and Mathematics
California State University, Long Beach

http://www.dropbox.com/sh/0pmxpmphwbhkcat/AACJ9vH39og4YZSkKSnpQ1gga?dl=0

FALL 2016 CNSM STEM Student Success Seminar Program (S^4P) GROWTH MINDSET
THURSDAYS, 9:30-11:00am, HSCI-156
Dates: Sept 15, Sept 29, Oct 27, Nov 10, Dec 8

Peer Mentor Training
https://www.mindsetkit.org/growth-mindset-mentors
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COE SUMMER BRIDGE AND BESST

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SOAR
ADVISING

MANDATORY FRESHMAN ADVISING
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Summer Orientation/Bridge Programs and Learning Communities

Science and Math Enrichment Program (SMEP)
Beach Engineering Student Success Team (BESST)

- Learning community program for Engineering freshman
- Serving our capable but ‘at risk’ students
- 25 or fewer students per cohort
- 1 week summer bridge program
- Single classroom for all cohorts
- Math, Math S/I, English/COMM, ENGR 101 & 102

- Mentors/Tutors assigned to the cohort
- Field trips (1-2 per semester)
- Guest Speakers
  - (career develop., study skills, etc.)
- Scholarship incentive
  - $1000 for 3.0 GPA or better
- Staff director

https://www.csulb.edu/college-of-engineering/prospective-students/besst
Beach Engineering Student Success Team (BESST)

https://www.csulb.edu/college-of-engineering/prospective-students/besst
College is a gym for your brain.
Be ready for a really good workout!

This week we will learn about our brains and learn about learning.
Especially YOUR MINDSET about learning.
Making mistakes is **THE** most useful thing you can do to learn math.

It is no big deal whether you make a mistake, what you do **immediately after** making a mistake that is a very big big deal!

Struggle = Your Brain Growing
**Sample Activity:** Let’s try to visualize two-dimensional cross-sections of three-dimensional objects.

**Solo (Independent) Activity:** “Vessels of Water”
- Imagine it takes 6 seconds for the water to flow out of each of the 3D vessels.
- Sketch a diagram of the surface of the water inside the vessel at: 1s, 2s, 3s, 4s, and at 5s.

This exercise comes from the Mathematics Assessment Resource Service, University of Nottingham & UC Berkeley.
Follow-up Lecture

Water Flowing Out of a Cylinder

3D View:

Top view – surface of water:

http://map.mathshell.org/lessons.php?unit=9340&collection=8&redir=1
Group Activity: “Vessels of Water”

Working Together

1. Your task is to match each set of shapes of the surface of the water with either a top or bottom container.

2. Some of the cards are missing shapes. You will need to draw these.

3. Take turns to match two cards. Explain to the rest of the group how you came to your decision.

4. Your partner(s) should either explain that reasoning again in his/her own words, or challenge the reasons you gave.

5. Place your cards on the poster. Next to them, record your jointly agreed justification for the match.

Everyone in your group needs to be able to agree on and explain the match of every card.
AY 2014-15: • 1 cohort
• 19 students, 3 left

BESST: YEAR 1 RESULTS

Math 122 (Calculus I) Final Grades

- A's: 59%
- B's: 36%
- C's: 5%

First year Overall GPA:
- Average GPA: 3.31
- 18 Students earned a GPA above 3.0
**BESST 2015-16 - Track 1**
(Math 111 and Math 113)

**BESST VS. MATH DEPT.**

- 30.72% Not 'At Risk' (Earned only As and Bs in Math 111 and Math 113)
- 28.18% 'At Risk' (Earned 1-C and 1-B or 1-A, or 2-Cs in Math 111 and Math 113)
- 41.11% 'Unqualified' (Earned at least one D, F or W in Math 111 and Math 113)

**BESST 2015-16 – Track 2**
(Calculus I)

- 44% No. of As = 3
- 28% No. of Bs = 8
- 11% No. of Cs = 5
- 17% No. of Ds = 2

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**BESST: YEAR 2 RESULTS**
Year 1 – 1 Cohort, 25 Students

Year 2 – 2 Cohorts, 48 Students
**CNSM SUMMER ORIENTATION AND FLCs**

**ASSESSMENT OF NON-COGNITIVE ACADEMIC SKILLS — TARGETED MINDSET INTERVENTIONS**
- [http://web.csulb.edu/colleges/cnsm/advising/howtosucceed.html](http://web.csulb.edu/colleges/cnsm/advising/howtosucceed.html)

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**SOAR ADVISING**

**MANDATORY FRESHMAN ADVISING**
- Intrusive Advising Interventions (Pretest / Early Warning / GPA Interventions)

**SUMMER**
**FALL**
**SPRING**
ONE DAY CNSM SUMMER ORIENTATTION PROGRAM

CNSM Peer Mentors
http://web.csulb.edu/colleges/cnsm/students/peertutors/

Growth Mindset for Mentors:
https://www.mindsetkit.org/growth-mindset-mentors
• How was this activity for you?

• What was your plan when you stepped up the grid? Did you have a strategy?

• How did you feel when you heard “yes”? What about “no”?

• What did you feel when you didn’t have help from your teammates? When you couldn’t help?

• How does this activity connect to academic grit and succeeding amidst challenges?
• There are two different types of mindset: fixed and growth.
  • Developed by Carol Dweck, Stanford University psychologist.
  • Mindsets are beliefs about yourself and your most basic qualities.
    • Intelligence, temperament, and talent are either fixed or can be developed.
  • Those with a fixed mindset believe these qualities can’t be changed.
    • Talent alone creates success and you must always prove your intelligence and talent to others.
  • Those with a growth mindset believe that these qualities can be cultivated.
    • Effort, hard work, practice, learning, and resilience is the key to any and all success.
Day 1 – metacognition / syllabus / learning skills

Day 2 – academic lecture (chemistry)

Day 3 – pretest jitters / exam / how are exams created / learning from exam / growth mindset
How are exams created

Learning from exam
# MINDSET RECAP

<table>
<thead>
<tr>
<th>FIXED MINDSET THINKING</th>
<th>GROWTH MINDSET THINKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACHIEVEMENT...</td>
<td>means proving you’re smart.</td>
</tr>
<tr>
<td>BEING SMART...</td>
<td>means that you’re making no mistakes.</td>
</tr>
<tr>
<td>A SETBACK OR MISTAKE...</td>
<td>leads to loss of confidence.</td>
</tr>
<tr>
<td>FAILURE...</td>
<td>leads to humiliation.</td>
</tr>
<tr>
<td>EFFORT...</td>
<td>shouldn’t be required if you’re smart and takes away excuses for failure.</td>
</tr>
<tr>
<td>SUCCESS...</td>
<td>is defined as being the best and is based on talent.</td>
</tr>
<tr>
<td>A BAD GRADE...</td>
<td>means it’s time to give up.</td>
</tr>
<tr>
<td>FEEDBACK...</td>
<td>is threatening, as it provides good or bad news about precious traits.</td>
</tr>
<tr>
<td>THE NEED TO ASK FOR HELP...</td>
<td>indicates a weakness or deficiency which should not be admitted.</td>
</tr>
<tr>
<td>STEREOTYPE THREAT...</td>
<td>is high due to fears of confirming negative stereotype.</td>
</tr>
<tr>
<td>TALENTED PEERS...</td>
<td>become grounds for feeling threatened and jealous.</td>
</tr>
</tbody>
</table>

* means that you’re learning and stretching. |
means that you’re confronting a challenge and making progress. |
indicates an area for growth. |
means that you’re not yet fulfilling potential. |
is the path to mastery that makes you smarter. You get out what you put in. |
is defined as working hard to become your best and is based on motivation. |
means it’s time to work harder. |
is welcomed, as it provides useful direction toward areas to work on. |
is a useful strategy for growth. |
is low, a stereotype is simply someone else’s inaccurate view of their abilities. |
are a source of inspiration. |
PRACTICING MINDSET

The desire to look smart.

A: Growth    B: Fixed
PRACTICING MINDSET

This is going to take some time but I’ll get there.

A: Growth  B: Fixed
PRACTICING MINDSET

Not everyone is good at Physics. Just try your best.

A: Growth  B: Fixed

#smepCSULB
PRACTICING MINDSET

Trying harder makes you smarter.

A: Growth  B: Fixed
PRACTICING MINDSET

I’m just not good at biochemistry.

A: Growth  B: Fixed
PRACTICING MINDSET

I’m just not good at biochemistry...yet

A: Growth  B: Fixed

#smepCSULB
Learning communities are formed by requiring selected first time freshman to enroll simultaneously in a cluster of chemistry and algebra courses including Algebra Supplemental Instruction, and Freshman Science Success Class. Each student is additionally assigned peer mentor who serves as a TA in the science success class.

http://web.csulb.edu/colleges/cnsm/students/fslc/
CHEMISTRY CLASS / MATH CLASS / SUPPLEMENTAL INSTRUCTION / SCIENCE SUCCESS CLASS HOMEWORK HELP HOUR WITH PEER MENTORS

- WELCOME EVENT
- NEWSLETTER
- MIDTERM PREPARATION
- INDIVIDUAL PEER MENTORING
- SPRING REGISTRATION PRIORITY
- GUARANTEED SUPPLEMENTAL INSTRUCTION

68% of FSLC participants successfully completed both algebra and chemistry and 85% completed at least one class vs. 46% and 69% in the comparison group
Mean change in confidence in Math 113 by community type with all respondents and with only CNSM students. Error bars are +/- SE. Sample sizes are indicated above each bar.
ALEKS PLACEMENT and COURSE REDESIGN

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Course Redesign in Key Gateway Courses

College Algebra

Calculus I and II

General Chemistry I and II

General Physics I and II

Approaches

Learning Assistants Model

Social Homework

Adaptive Learning Homework

Supplemental Instruction

Course Placement via Adaptive Assessment

ALEKS PPL

Targeted Tutoring

Flipped Instruction

http://courseredesign.csuprojects.org/wp/eportfolios/
CALCULUS PLACEMENT VIA ALEKS PPL FOR ALL CSULB STEM STUDENTS FREE OF CHARGE, TOTAL COST ~$40k

<table>
<thead>
<tr>
<th></th>
<th>% FTF</th>
<th>FTF PASS RATE</th>
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<tbody>
<tr>
<td>FALL '11</td>
<td>33.10%</td>
<td>66.40%</td>
</tr>
<tr>
<td>FALL '12</td>
<td>33.10%</td>
<td>63.40%</td>
</tr>
<tr>
<td>FALL '13</td>
<td>49%</td>
<td>65.80%</td>
</tr>
<tr>
<td>FALL '14</td>
<td>61.80%</td>
<td>73.80%</td>
</tr>
<tr>
<td>FALL '15</td>
<td>70.80%</td>
<td>72.60%</td>
</tr>
<tr>
<td>FALL '16</td>
<td>79.10%</td>
<td></td>
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</tbody>
</table>
CALCULUS I and II REDESIGN

• “We are working within a department whose faculty value autonomy in the classroom; thus, our approach seeks to avoid any interference, intervention, or change in the way they approach teaching.” (...one of the TT faculty participants...)

• Uniform homework and “benchmark” pre-tests administered through WebAssign. Content determined by the Calculus Committee.

• Identification of at-risk students and mandatory intervention in the form of 75-minute weekly tutorials for the bottom 30% based on exam scores (4 midterm exams) taught by TAs or undergraduate students
CALCULUS I and II REDESIGN

Redesigned sections compared with non-redesigned sections past and present

122 → 123 GPA change

<table>
<thead>
<tr>
<th></th>
<th>MATH 123 PARTICIPATING</th>
<th>MATH 123 NON-PARTICIPATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 122 PARTICIPATING</td>
<td>2.41 (-0.54)</td>
<td>2.28 (-0.57)</td>
</tr>
<tr>
<td>MATH 122 NON-PARTICIPATING</td>
<td>2.34 (-0.44)</td>
<td>2.18 (-0.58)</td>
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MANDATORY FRESHMAN ADVISING
Intrusive Advising Interventions (Pretest / Early Warning / GPA Interventions)

SUMMER FALL SPRING
• The COE Degree Progress Rules were established in Fall 2010.
• Since then completion rates for the first year have steadily increased:
  - 63% in 2011
  - 77% in 2012
  - 86% in 2013

https://www.csulb.edu/college-of-engineering/student-success/academic-advising
Pre-Major Requirements

COE Pre-major requirements started in Fall 2013.

Fall 2012 (without Pre-Major):
  Fully declared: 60%
  Left Major: 40%

Fall 2013 (with Pre-Major):
  Fully declared: 65.5%
  Remaining as Pre: 12.5%
  Left Major: 23%
PRINCIPLES OF INTRUSIVE ADVISING (PRETEST, EARLY ALERT, PROBATION):

- How did the student describe the situation?
- Growth Mindset or Fixed Mindset?
- Optimistic Explanatory Style
  - Proactive and problem-focused coping strategies
  - Take initiative
  - See the lessons in failure
  - Attributes failure to controllable causes
- Guiding Questions
  - Where am I going? (possible selves)
  - Where am I now? (mindset and attributional style)
  - How can I close the gap? (strategies)

https://www.viterbo.edu/sites/default/files/viterbo_nacada_visit_workshop.pdf
● FRESHMAN AND SOPHOMORE MATH, CHEMISTRY, BIOLOGY COURSES: instructors are asked to identify students “at risk” (week 5-6)

● advisors notified, students underperforming in 2 courses are identified. The students receive additional advising and mentoring.
ENGINEERING: Honors Program

- For academically successful and motivated students
- Students will conduct research with a faculty advisor and write a thesis
- Graduate in 4 years

- Targeted the top 448 students offering a $5000 recruitment scholarship
- $2000 Year 1 + $1000 for 3 years (in EHP)

https://www.csulb.edu/college-of-engineering/programs/honors
4-year graduation rates have been flat:

- averaging 5.3% from Fall 2006 to Fall 2010
- On average, 20 FTF per year have graduated in 4-years

Looking only at EHP graduation predictions:

- by Fall 2014 the 4-year rate will have increased by 50%
- by Fall 2015 it will have doubled
Improving First Year STEM Retention through Mathematics Placement, Learning Communities and Growth

**ASSESSMENT OF NON-COGNITIVE ACADEMIC SKILLS — TARGETED MINDSET INTERVENTIONS**
http://web.csulb.edu/colleges/cnsm/advising/howtosucceed.html

**ALEKS PPL**  
Calculus Placement

**CALCULUS SEQUENCE and GENERAL CHEMISTRY REDESIGNED**  
Redesigned via CSU CO Course Redesign with Technology Promising Practices

**COE BEACH ENGINEERING STUDENT SUCCESS (BESST) LEARNING COMMUNITY**  
2 sections@ 25 students, math / Eng. Comp. / ENGR 101 & 103 / supplemental instruction / tutoring  
Fall 2014 Pilot: 95% Calculus pass rate, 18 of 22 students earning above a 3.0 GPA

- ENGR 101 — Intro to Eng Profession
- ENGR 102 — Academic Success Skills

**CNSM FRESHMAN LEARNING COMMUNITIES**  
6 sections @ 26 students, Math. / Chem. / NSCI 190A / supplemental instruction / peer mentoring support  
Fall 2015 Pilot: “full completion” rate went from 45% to 70%

- NSCI 190A — Learning Strategies
- NSCI 190BA — Research Lab Shadowing

**SOAR ADVISING**

**MANDATORY FRESHMAN ADVISING**  
Intrusive Advising Interventions (Pretest / Early Warning / GPA Interventions)

**SUMMER**  
- COE BEACH ENGINEERING STUDENT SUCCESS (BESST) LEARNING COMMUNITY
  - ENGR 101 — Intro to Eng Profession
  - ENGR 102 — Academic Success Skills

**FALL**  
- COE BEACH ENGINEERING STUDENT SUCCESS (BESST) LEARNING COMMUNITY
  - ENGR 101 — Intro to Eng Profession
  - ENGR 102 — Academic Success Skills

**SPRING**  
- COE BEACH ENGINEERING STUDENT SUCCESS (BESST) LEARNING COMMUNITY
  - ENGR 101 — Intro to Eng Profession
  - ENGR 102 — Academic Success Skills
The California State University
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IMPROVING FIRST YEAR STEM RETENTION THROUGH MATHEMATICS PLACEMENT, LEARNING COMMUNITIES AND GROWTH MINDSET