

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

Tracy Bradley Maples, Acting Associate Dean, College of Engineering
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College of Natural Sciences and Mathematics

California State University, Long Beach

- 2650 students
 - 2246 undergraduate
 - 404 graduate
- 7 Departments
- 21 Degree Programs

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

COLLEGE OF ENGINEERING

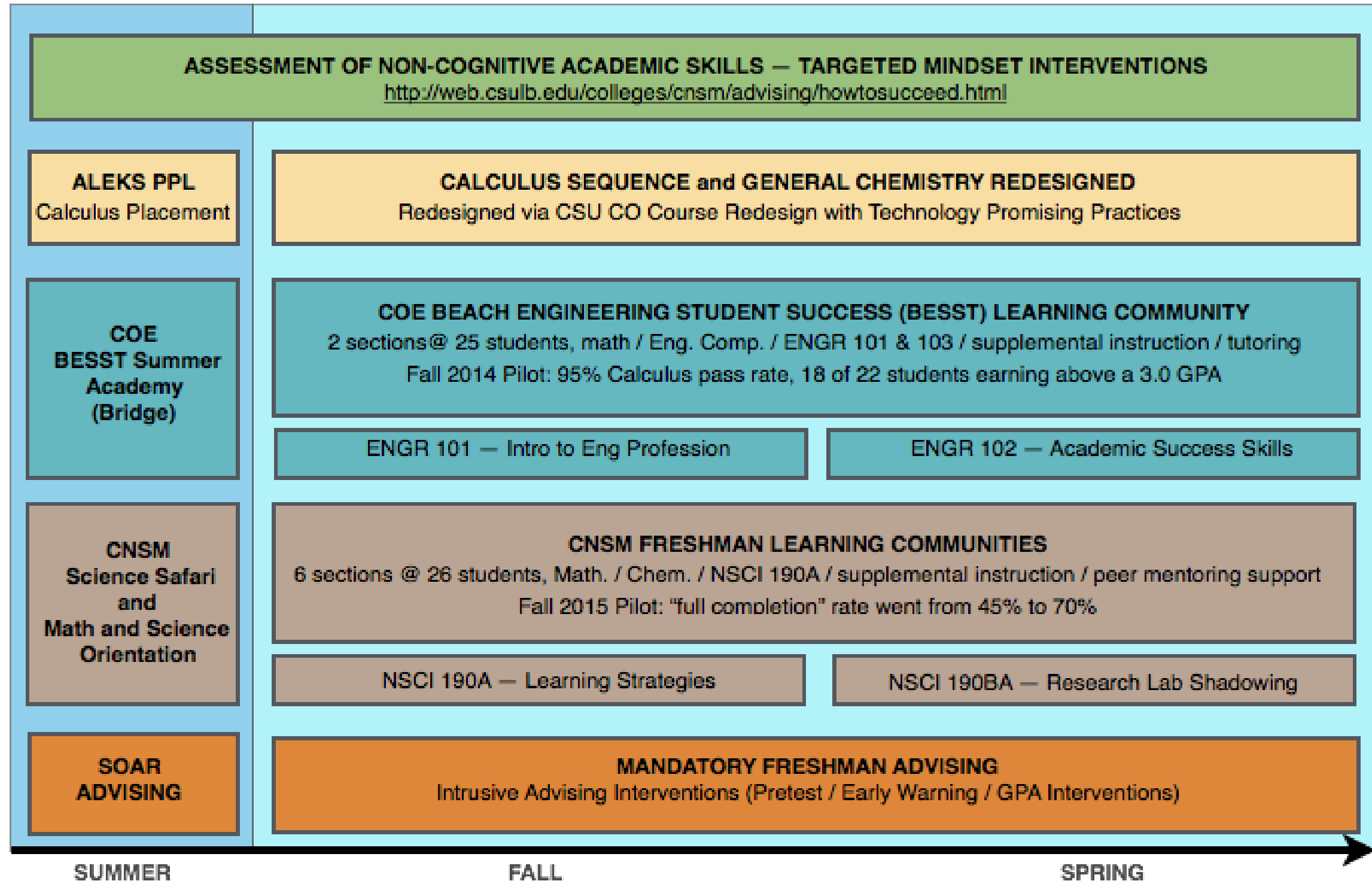


- 4716 students
 - 3917 undergraduate
 - 799 graduate
- 6 Departments
- 20 Degree Programs
- Joint PhD with Claremont Graduate School

<http://web.csulb.edu/colleges/coe/>

First we discuss:

- Institutional Context
- Inclusive Excellence and Graduation Rates





- Named a Top 75 ‘Best Value’ by Princeton Review
- Among Top 5 Nationally in Freshman Applications
- Ranked No. 4 in the West by U.S. News & World Report
- Named to Kiplinger’s Best Values in Public Colleges List
- Designated ‘Best in the West’ by Princeton Review
- Top 10 in Bachelor’s Degrees to Minority Students
- Designated a ‘Military Friendly School’
- Among Nation’s Top 10 in Degrees to Hispanics

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)

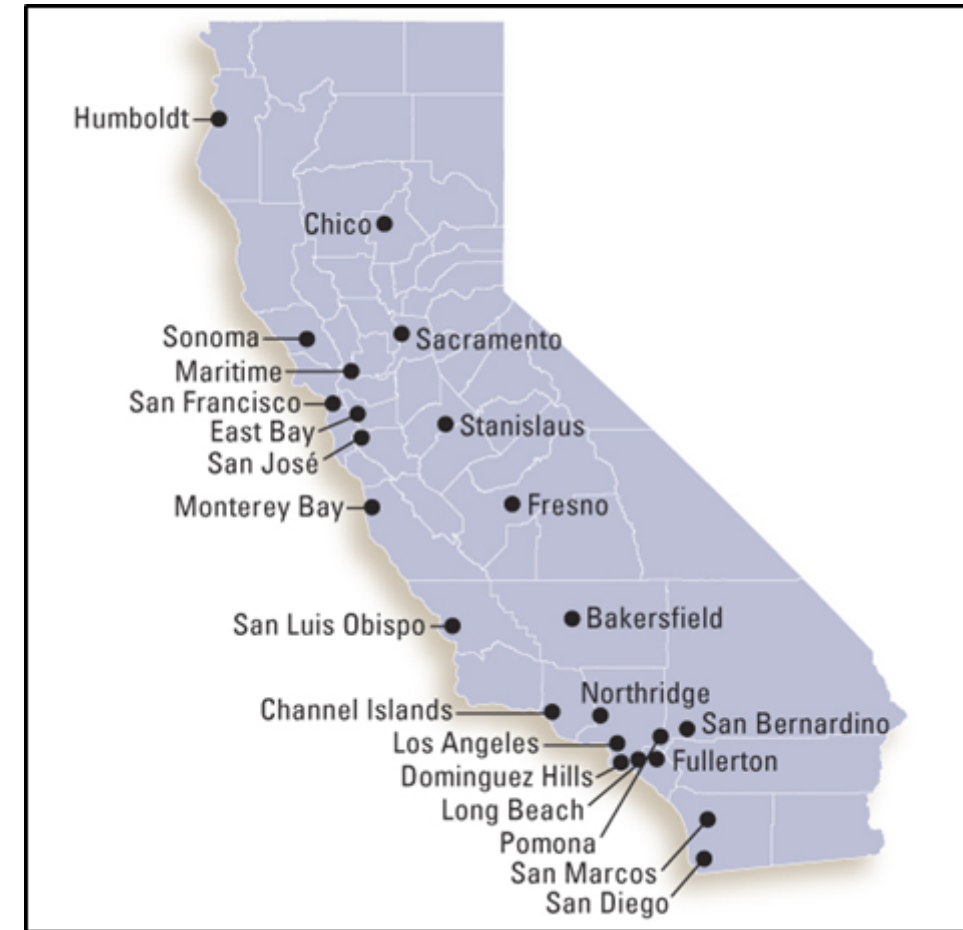
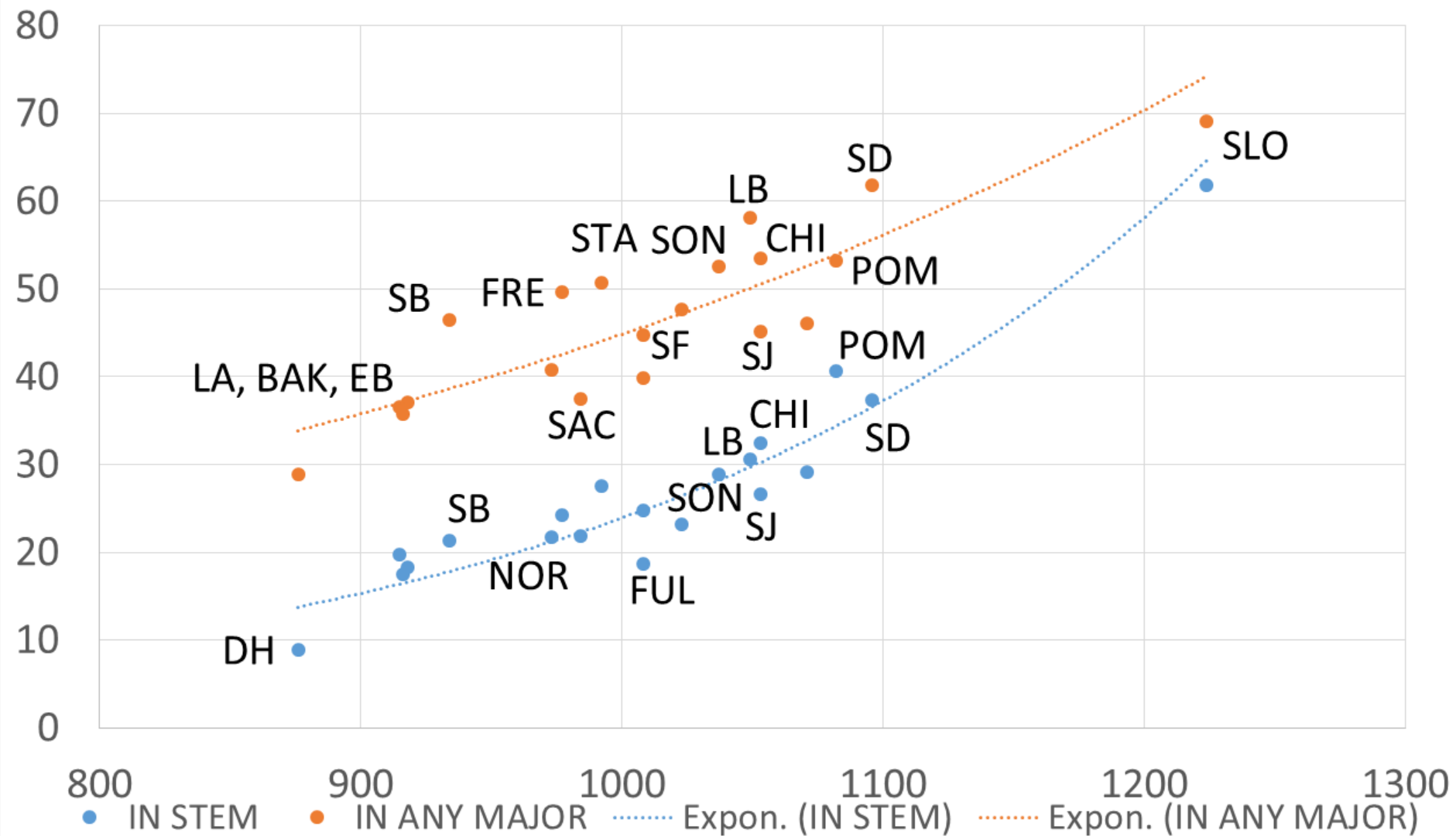
- SMI measures the extent to which a college or university educates more economically disadvantaged students (with family incomes below the national medium) at lower tuition so that they can graduate and obtain good paying jobs.
- SMI computed from five variables:
 - Published tuition
 - % of student body whose families are below the US median income
 - Graduation rate
 - Reported median salary 0-5 years after graduation
 - Endowment

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



IMPORTANT CONSIDERATIONS

CAMPUS-WIDE IMPACTION
MANDATORY
“DECLARATION REQUIREMENTS”



**CALC 1
AND CHEMISTRY**
GPA >2.5
BY 60 UNITS

FOCUS ON TIME TO DEGREE
MANDATORY
“DEGREE PROGRESS RULES”



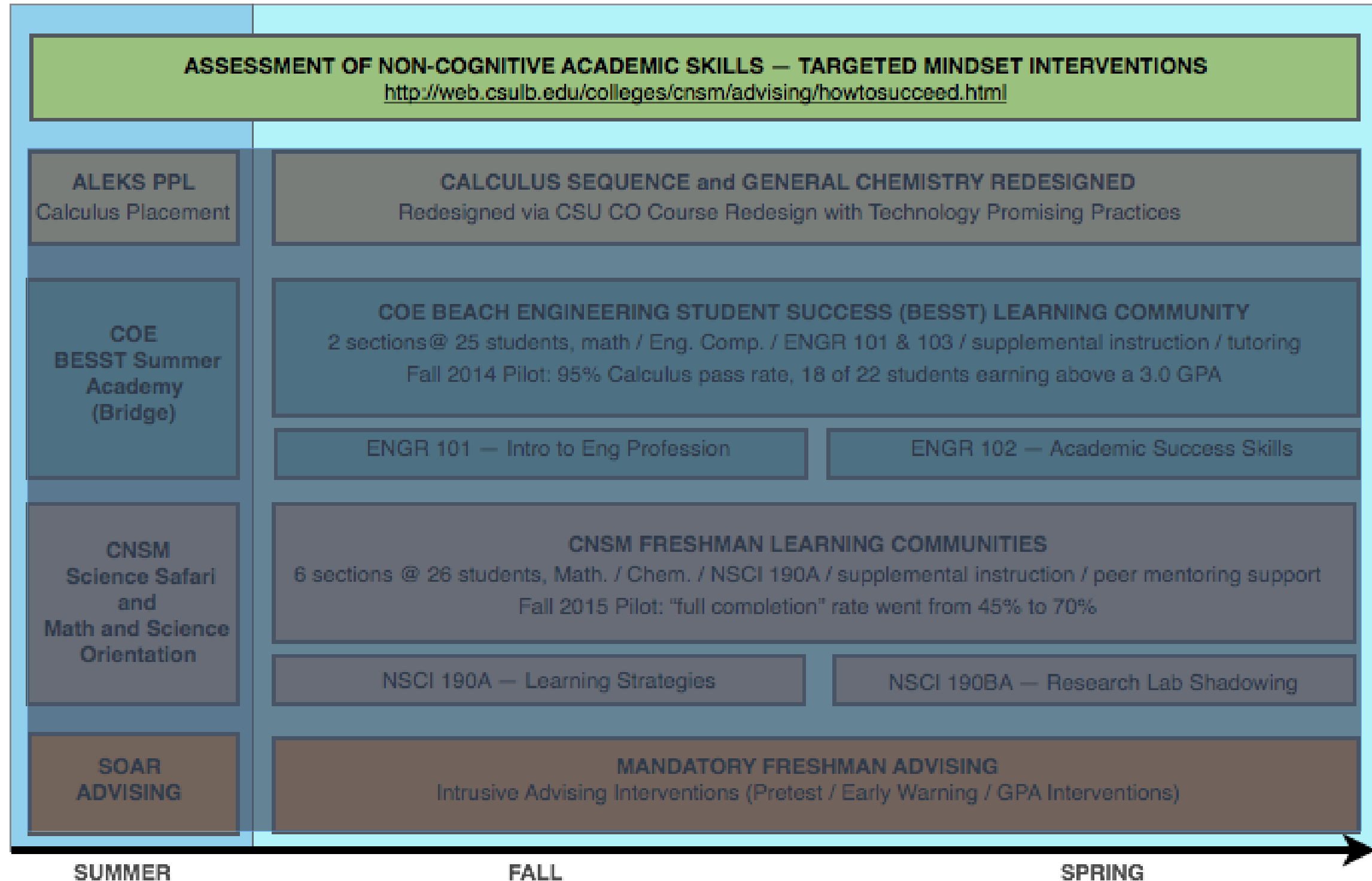
CALC 1
*BY END OF
FIRST YEAR*

CSULB INCLUSIVE EXCELLENCE

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



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?



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.



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.

A SOCIAL COGNITIVE APPROACH TO MOTIVATION AND PERSONALITY

By: DWECK, CS; LEGGETT, EL

PSYCHOLOGICAL

REVIEW Volume: 95 Issue: 2 Pages: 256

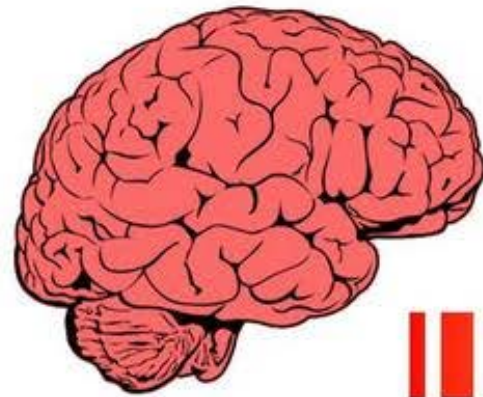
-273 Published: APR 1988

Times Cited: [2,584](#)

(from Web of Science Core Collection)

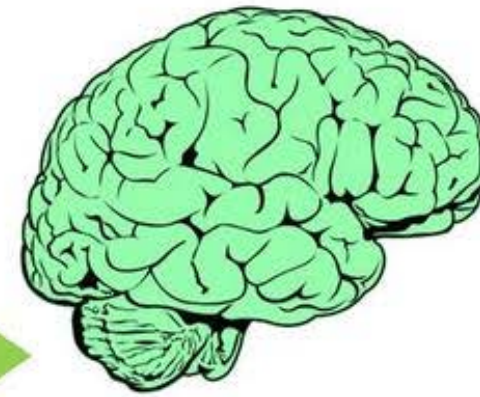
A Mindset Shift

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.

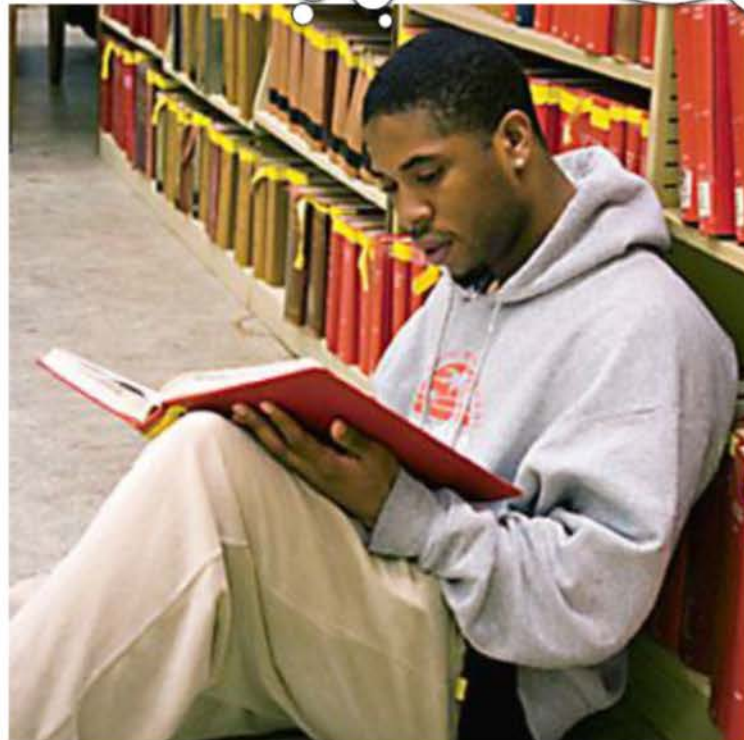
Consider where you would place yourself currently. Now think about what you can do to release your growth mindset.

Key principle: neuroplasticity

	Fixed Mindset	Growth Mindset
Goal in School?	Look Smart	Learn
Values effort?	No	Yes
Reaction to Failure?	Give Up	Work Harder
Achievement	Lower	Higher

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 Pag
es: 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](#)

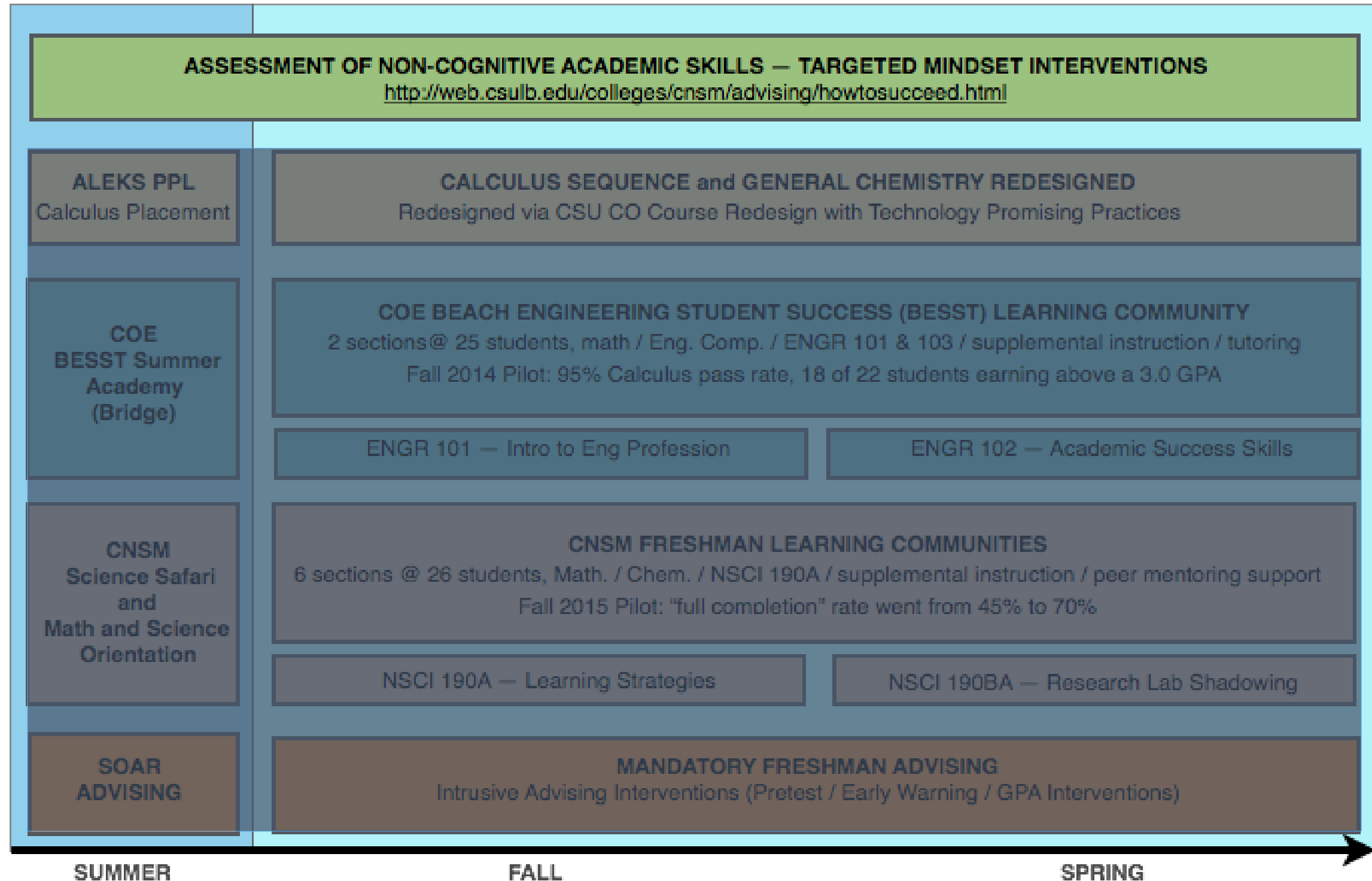
(from Web of Science Core Collection)

The Wall Street Journal
**A Small Fix in Mind-Set Can Keep
Students in School**
By Alison Gopnik
June 16, 2016 12:49 p.m. ET

The New York Times
**Conquering the Freshman
Fear of Failure**
By David L. Kirp
August 20, 2016

**Pre-matriculation lay
theory interventions
narrow first-year
achievement gaps when
delivered to entire
incoming classes.**







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/AACJ9vH39og4YZSkKSpnQ1gga?dl=0>

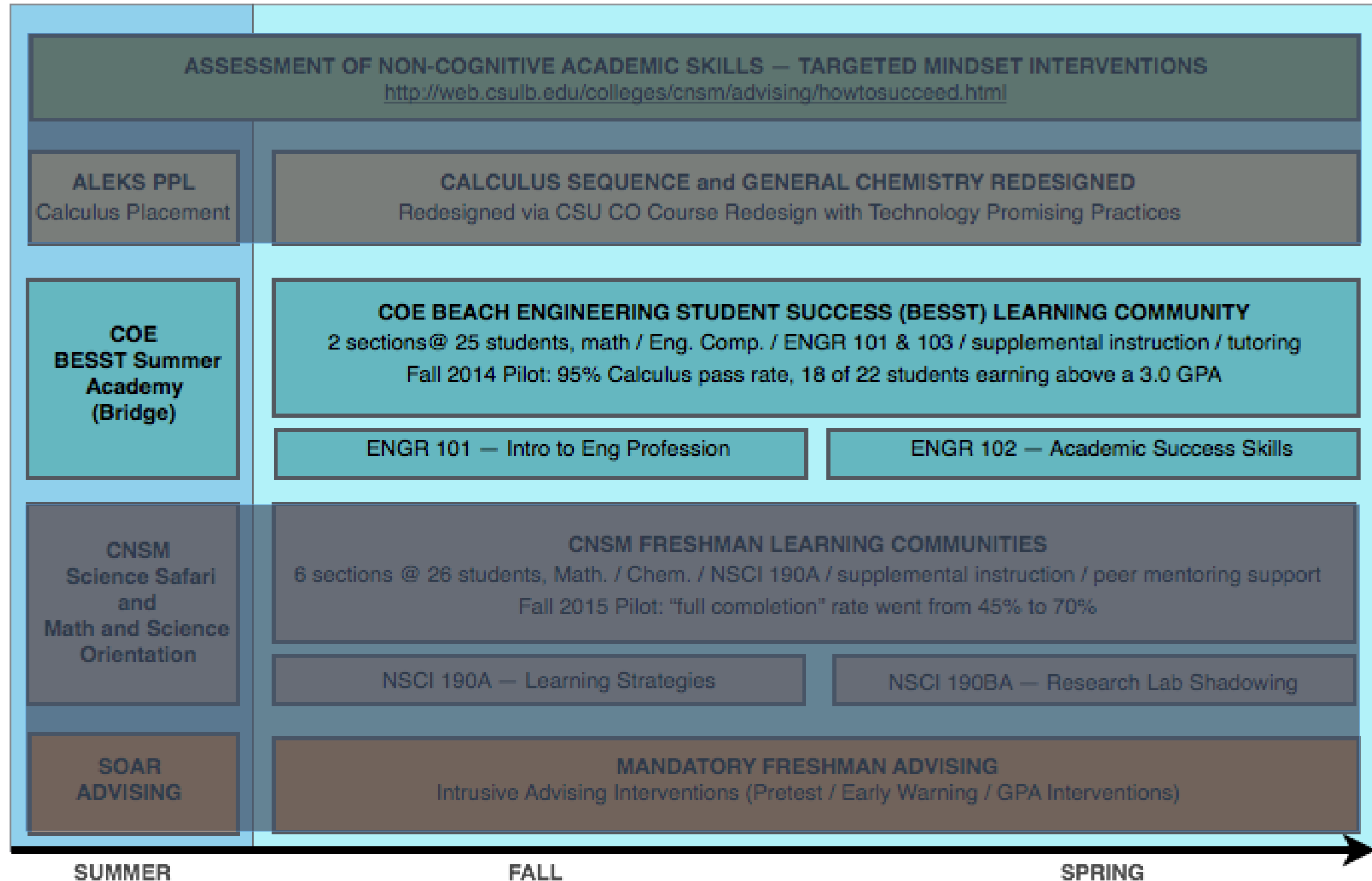
FALL 2016 CNSM STEM Student Success Seminar Program (S⁴P) GROWTH MINDSET

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>



Summer Orientation/Bridge Programs and Learning Communities

Science and Math Enrichment Program (SMEP)



MEP Math Enrichment Program The College of Engineering at California State University, Long Beach presents

Engineering Bridge

FOR INCOMING FRESHMEN

BENEFITS:

- Bookstore credit for books and supplies
- Higher chance to graduate in 4 years
- Develop a higher level of academic skills
- Special access to CSULB services and resources
- Form strong friendships among other freshmen who'll support your first year experience
- Opportunity to participate in student leadership workshops

CRITERIA:
Freshmen will be required to attend and enroll in the following courses for the semesters indicated below:

SUMMER 2015:	FALL 2015:	SPRING 2016:
• 5-Day Summer Bridge Residential Program (August 3-7, 2015) Deadline: July 20, 2015	• MATH 111 • MATH 113 • ENEL 100 • ENER 101	• MATH 122 • ENER 102 • COMM 130 (or Similar)

FREE!! Space is limited! Please apply by July 20, 2015
Brenda Medina, Program Coordinator
Call: (562) 835-4115 Email: Brenda.Medina@csulb.edu



FRESHMEN SCHOLARS LEARNING COMMUNITY

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



Beach Engineering Student Success Team (BESST)

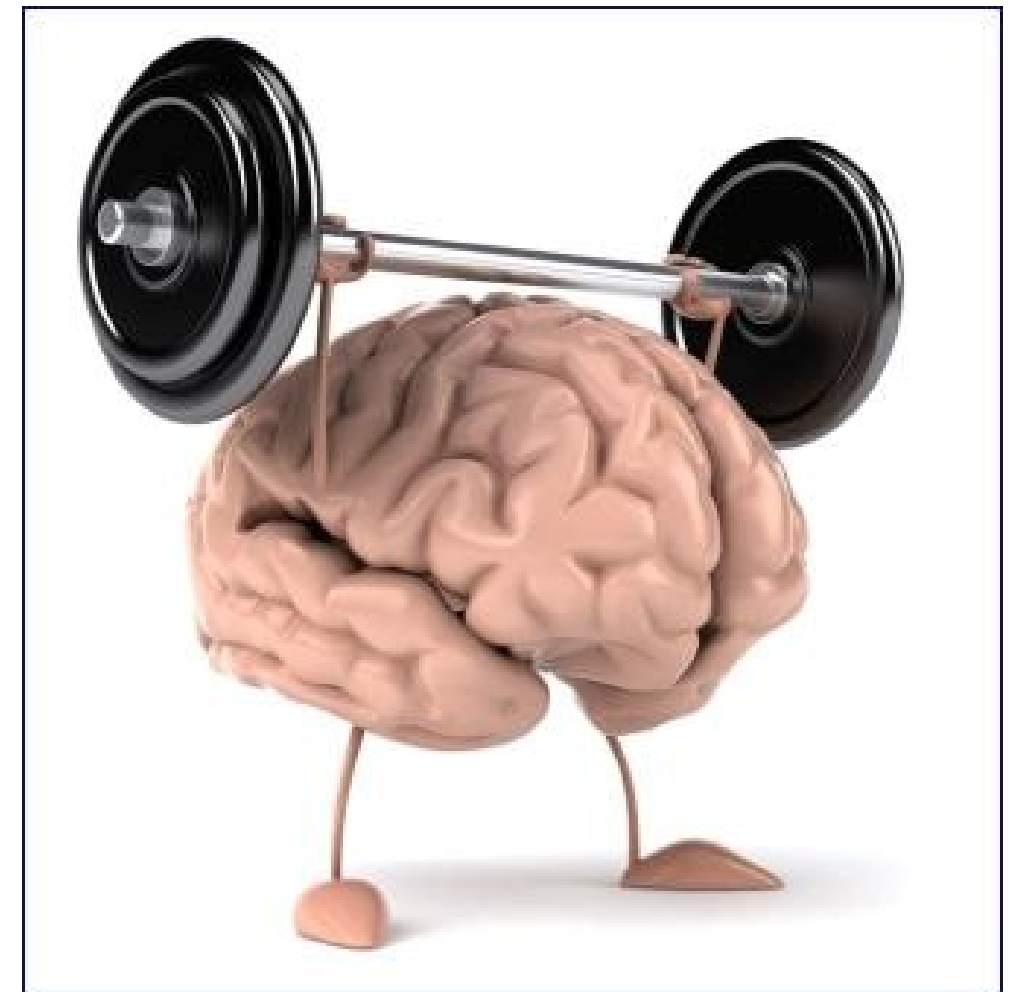


Andrea Johnson, Faculty

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.*

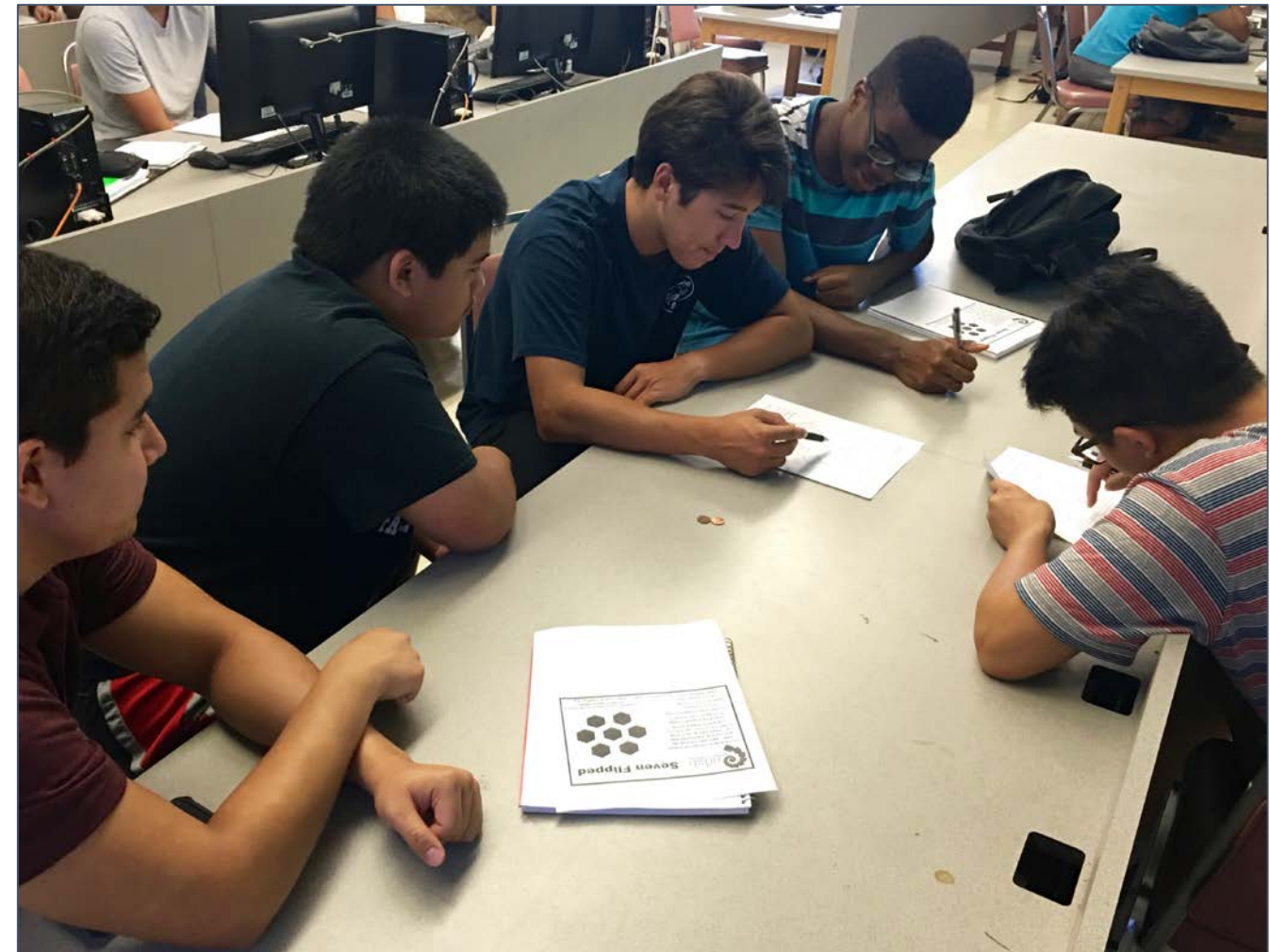
Especially YOUR MINDSET about learning.



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 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


Vessels of Water

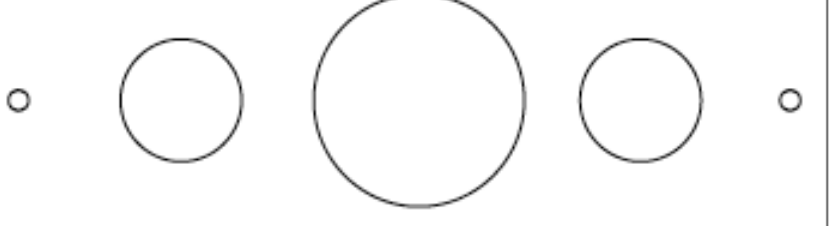
Below are representations of three-dimensional vessels. The three vessels are full of water.

Water flows out through a pipe in the bottom of each vessel.

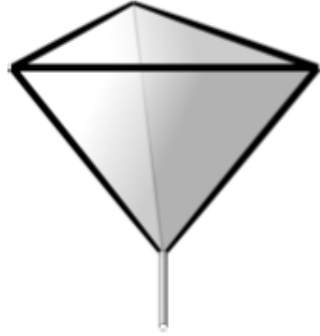
Sketch diagrams for each vessel to show how the shape of the surface of the water changes as the water flows out of each vessel. For each of your drawings describe the shapes formed.

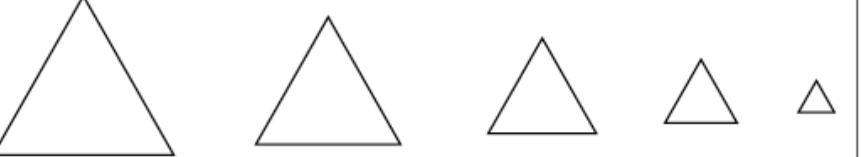
1. Sphere







2. Regular tetrahedron



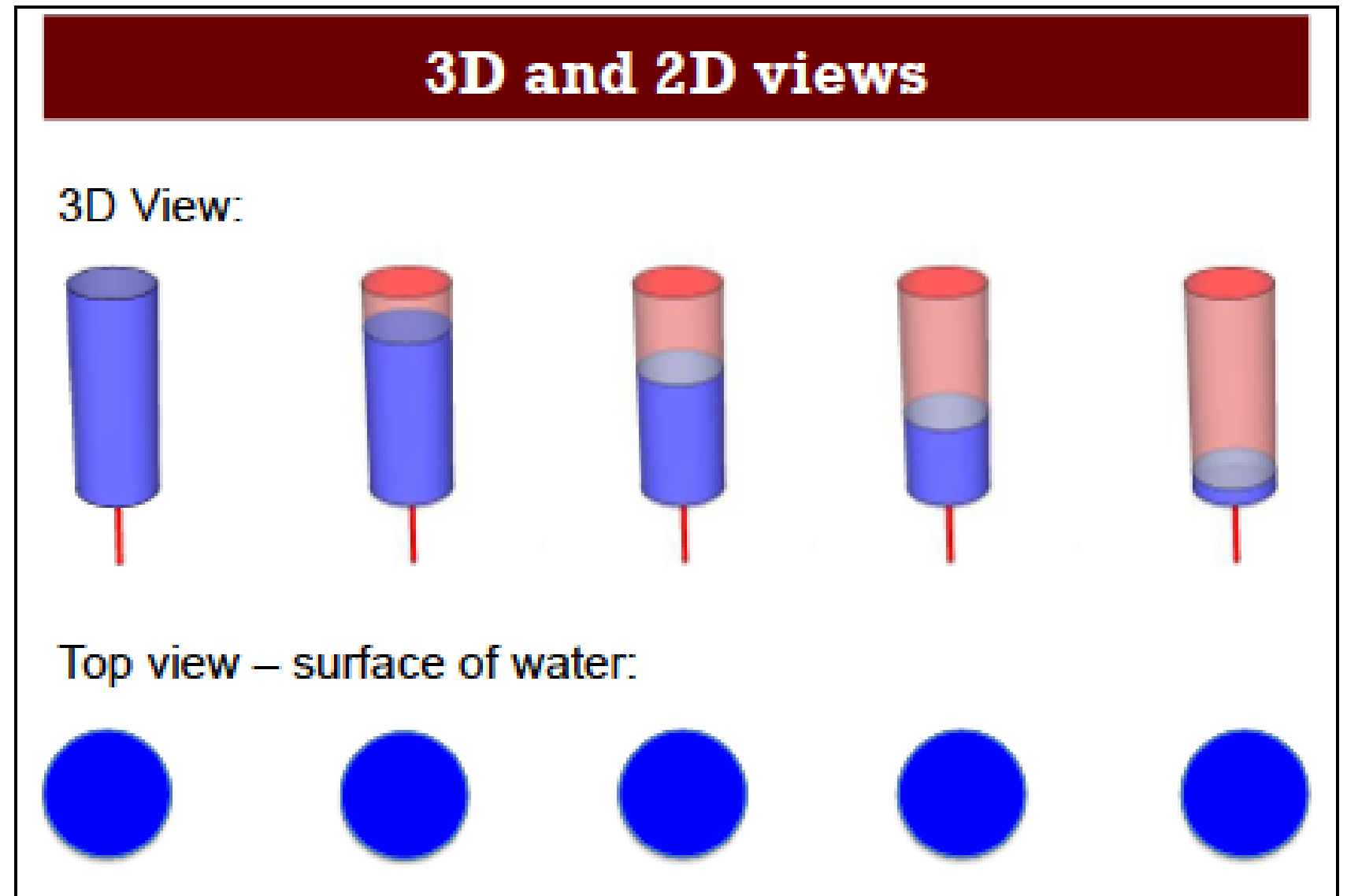
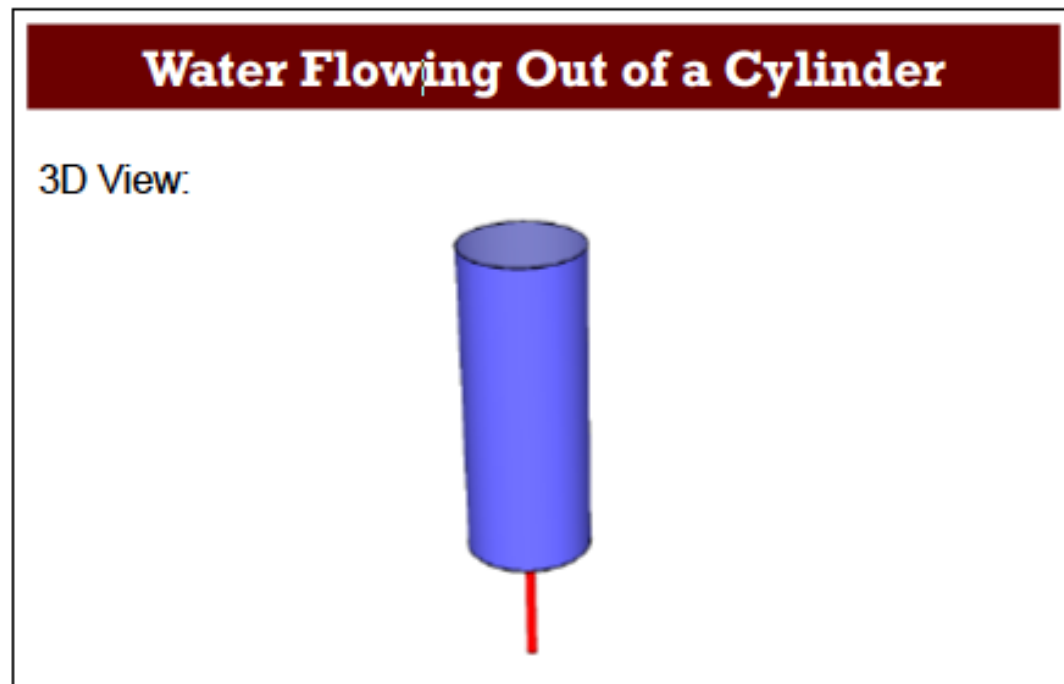


3. Cube





Follow-up Lecture



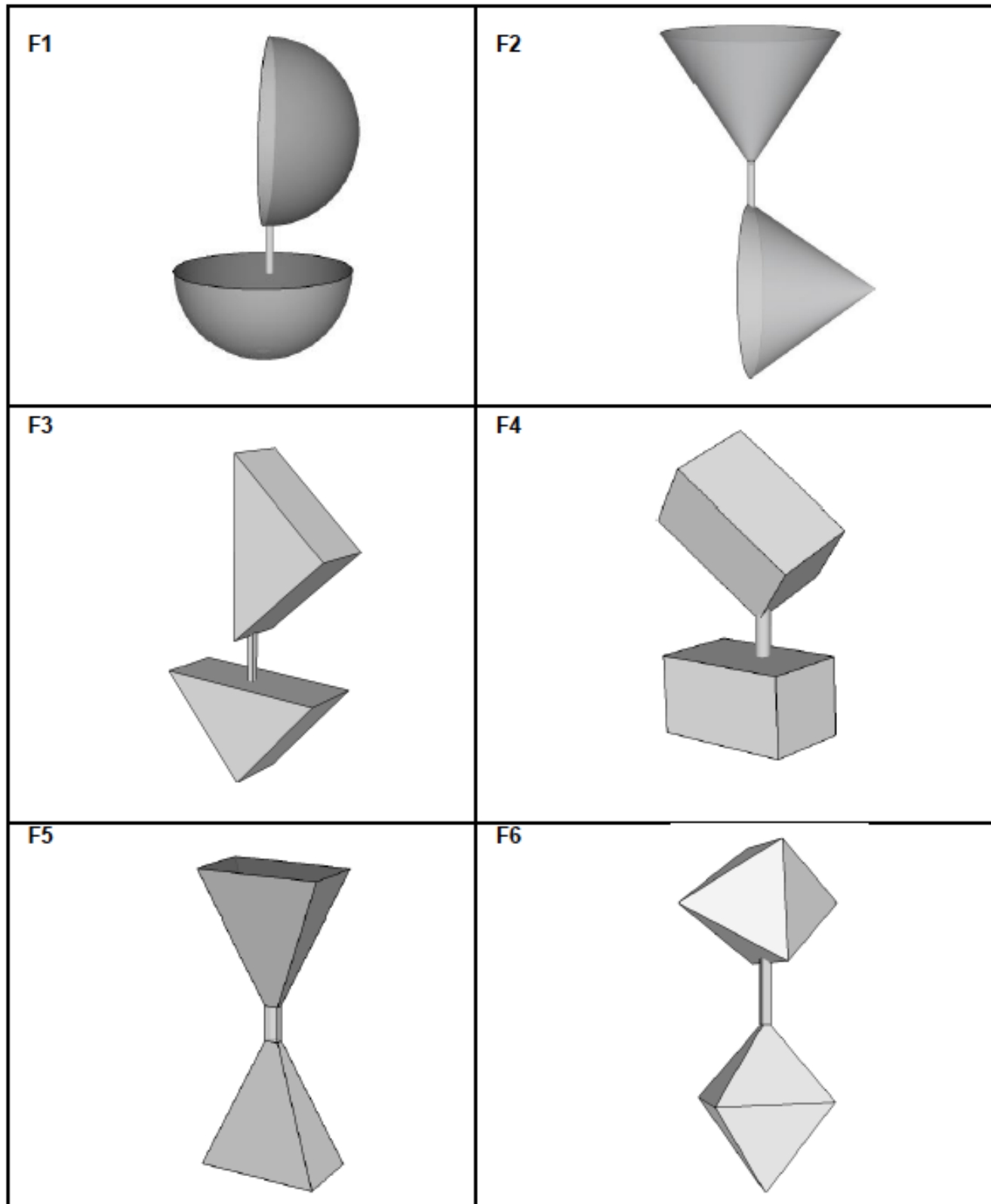
Group Activity: “Vessels of Water”

Working Together

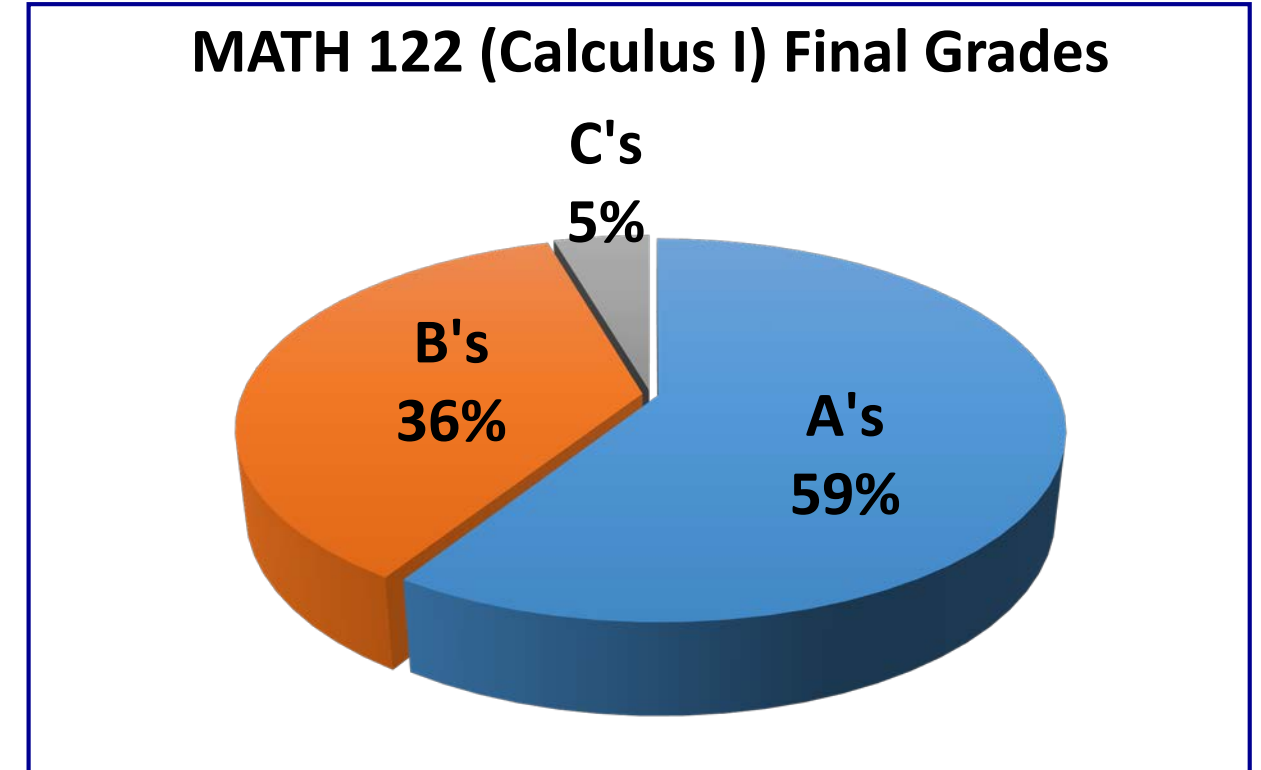
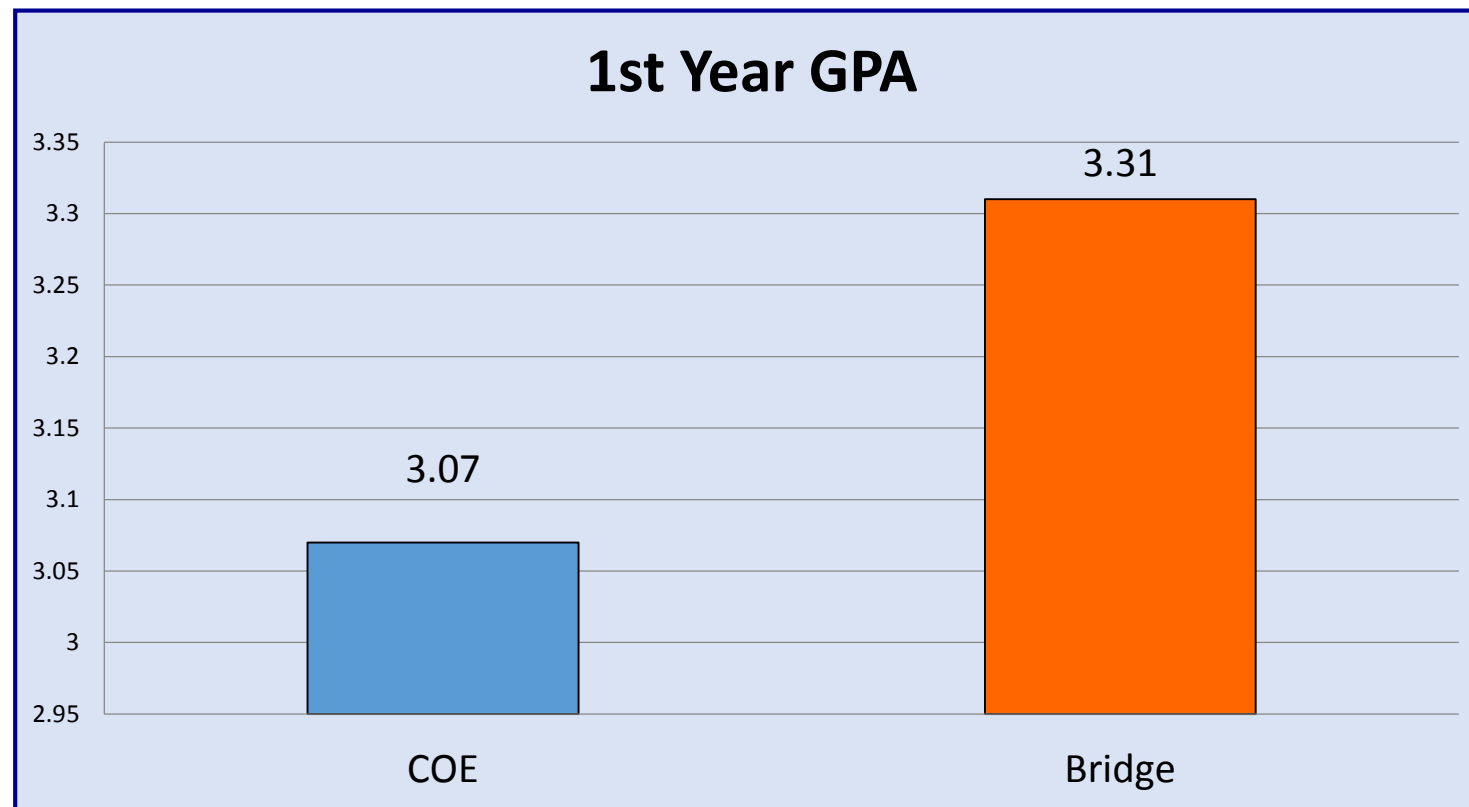
1. Your task is to match each set of shapes of the surface of the water with either a top or bottom container.
2. Some of the cards are missing shapes. You will need to draw these.
3. Take turns to match two cards.
Explain to the rest of the group how you came to your decision.
4. Your partner(s) should 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.

Card Set: Flowing Water



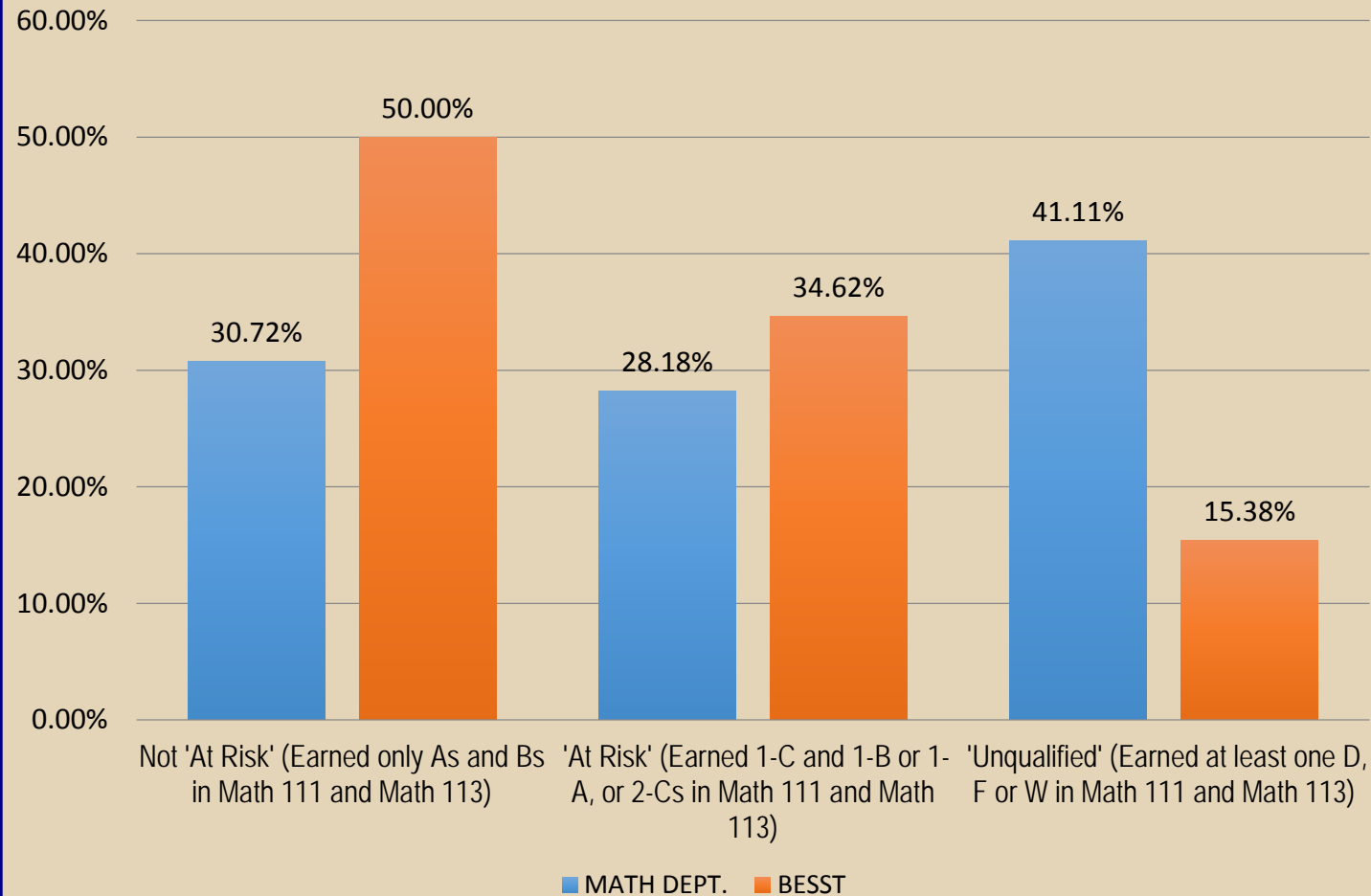
AY 2014-15: • *1 cohort*
• *19 students, 3 left*



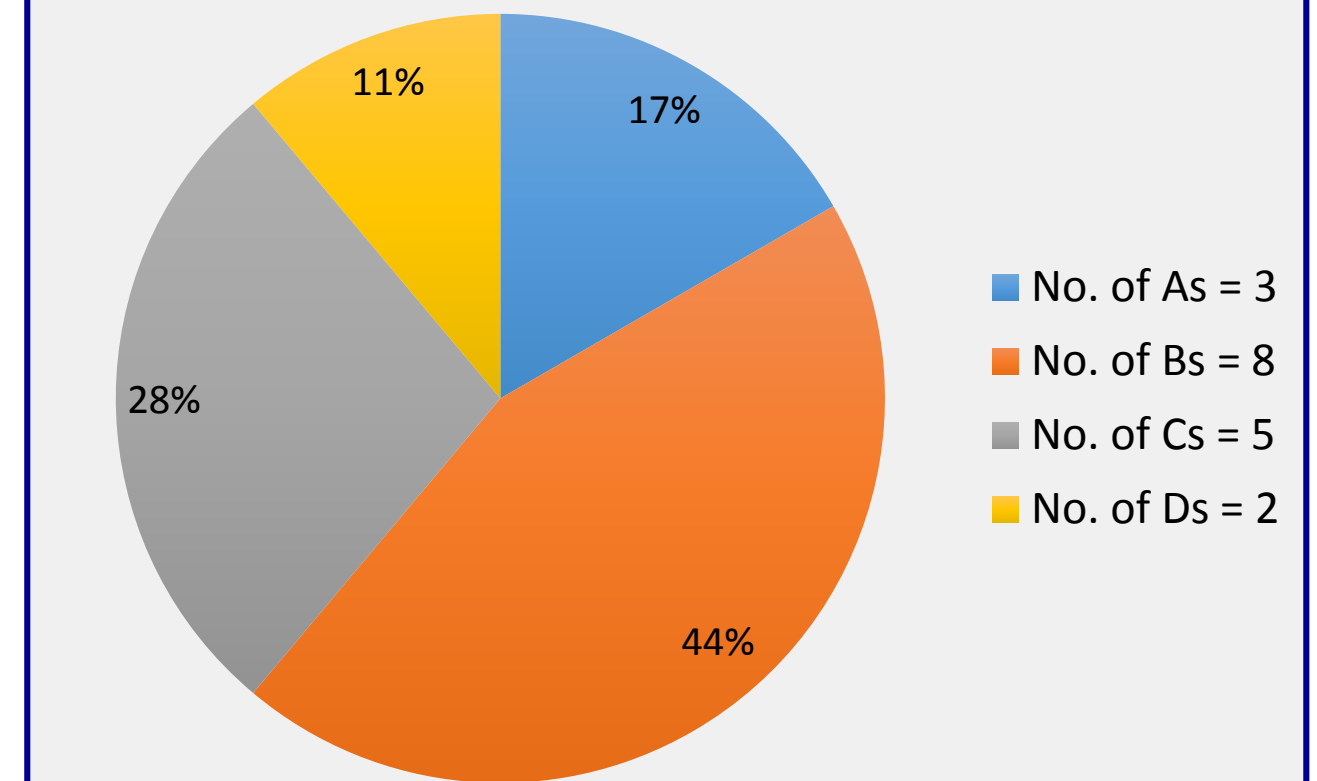
First year Overall GPA:

- Average GPA: 3.31
- 18 Students earned a GPA above 3.0

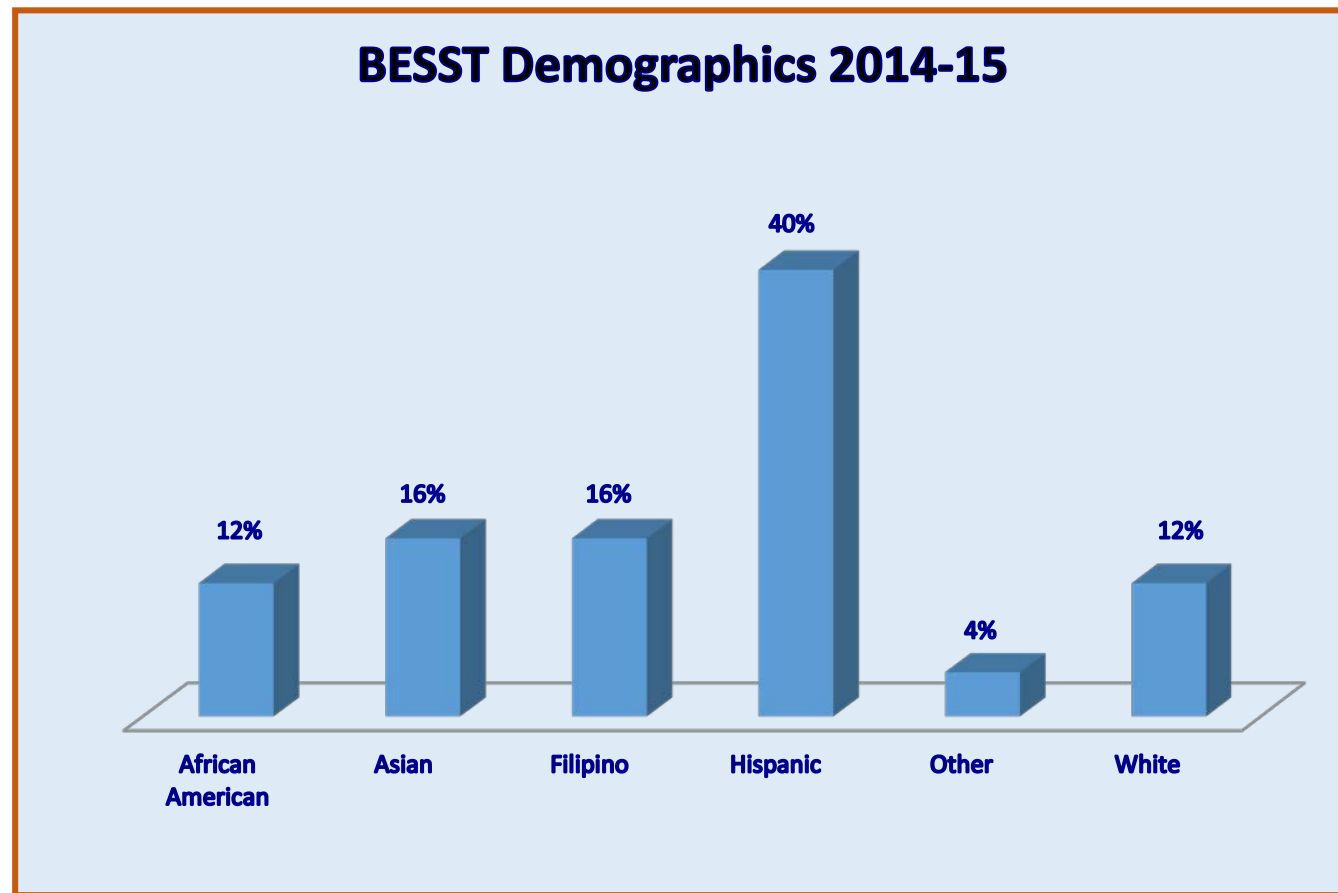
**BESST 2015-16 - Track 1
(Math 111 and Math 113)
BESST VS. MATH DEPT.**



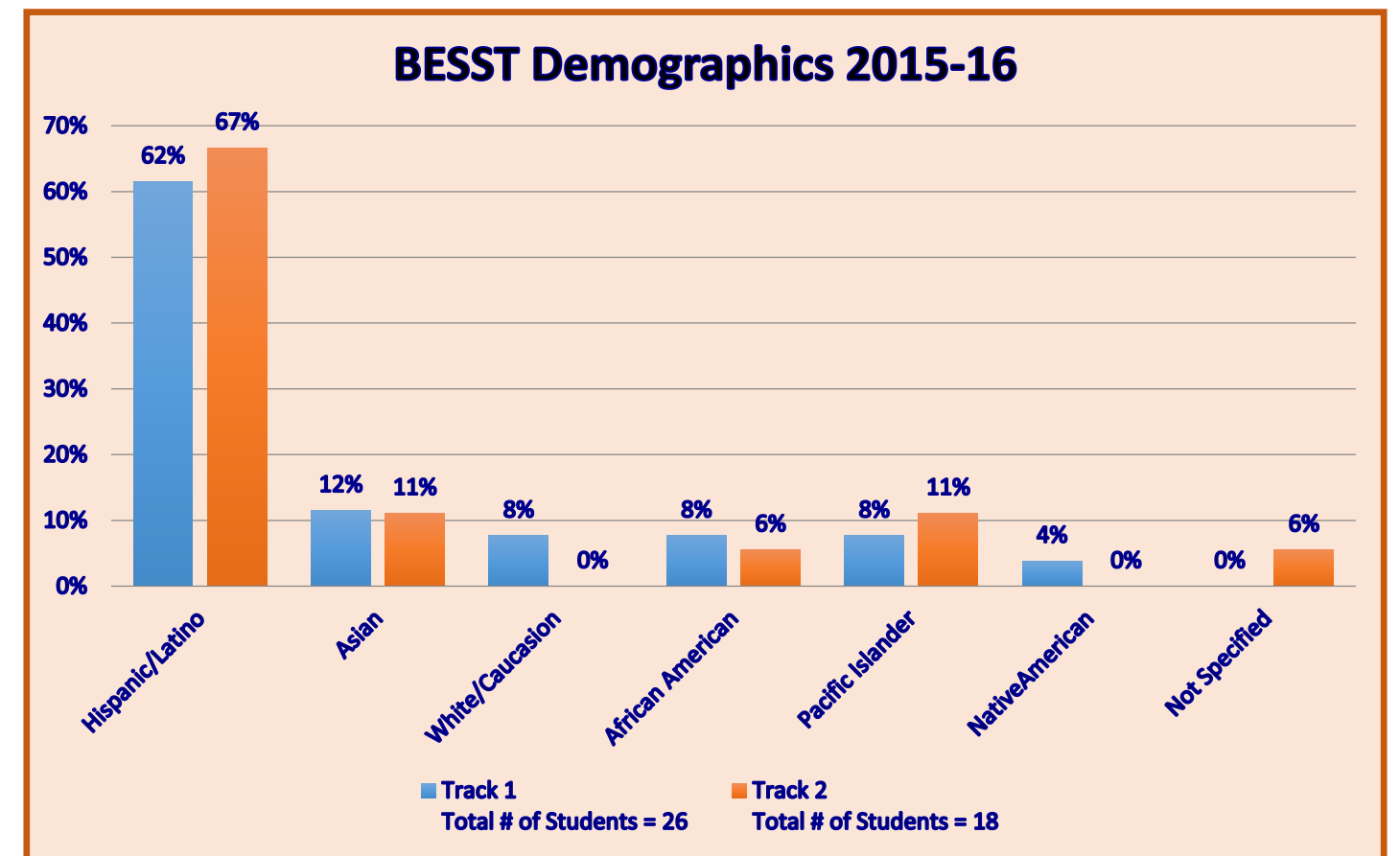
**BESST 2015-16 – Track 2
(Calculus I)**

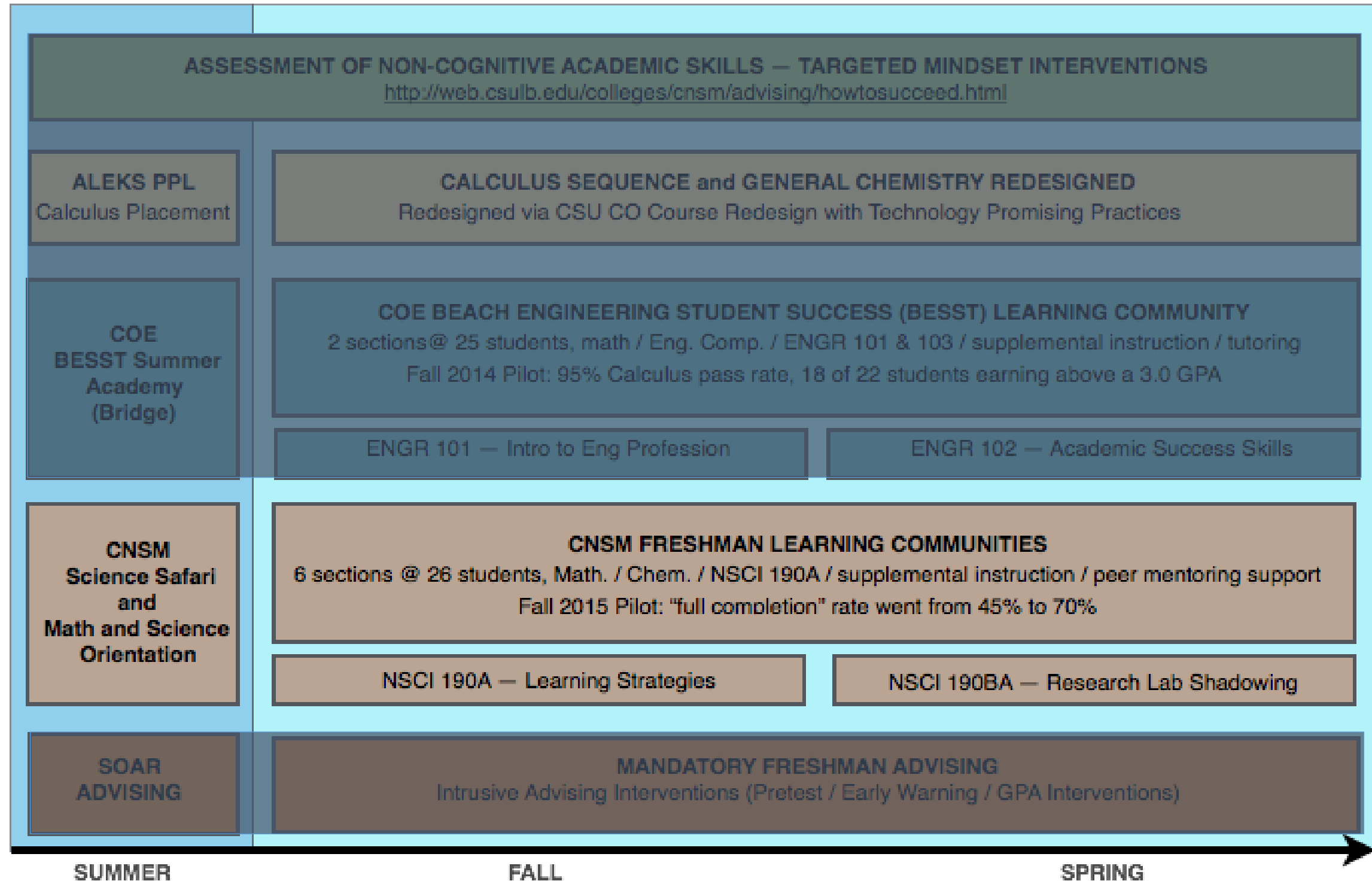


Year 1 – 1 Cohort, 25 Students



Year 2 – 2 Cohorts, 48 Students



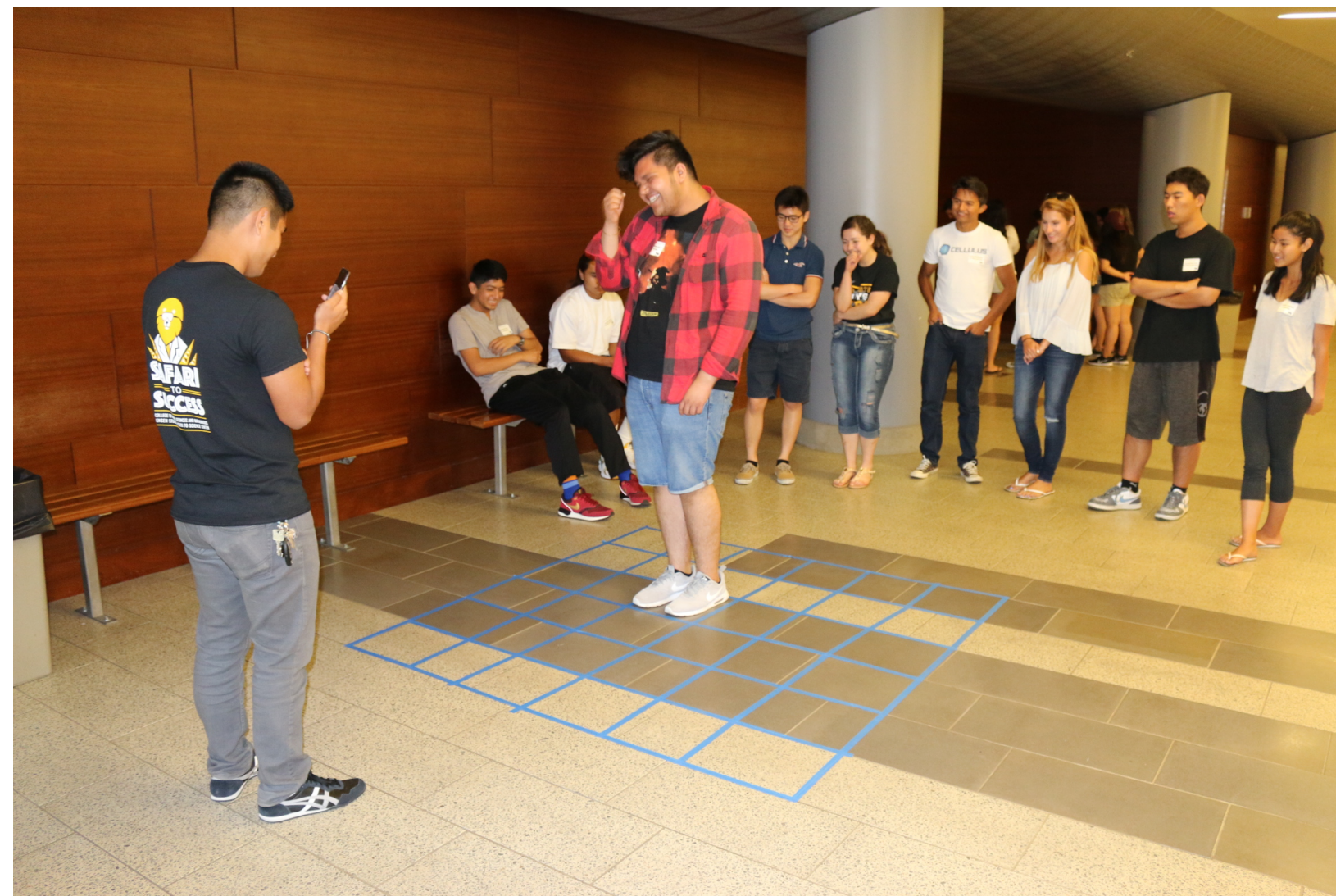




The California State University
ACADEMIC AND STUDENT AFFAIRS



ONE DAY CNSM SUMMER ORIENTATION 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

Metacognition

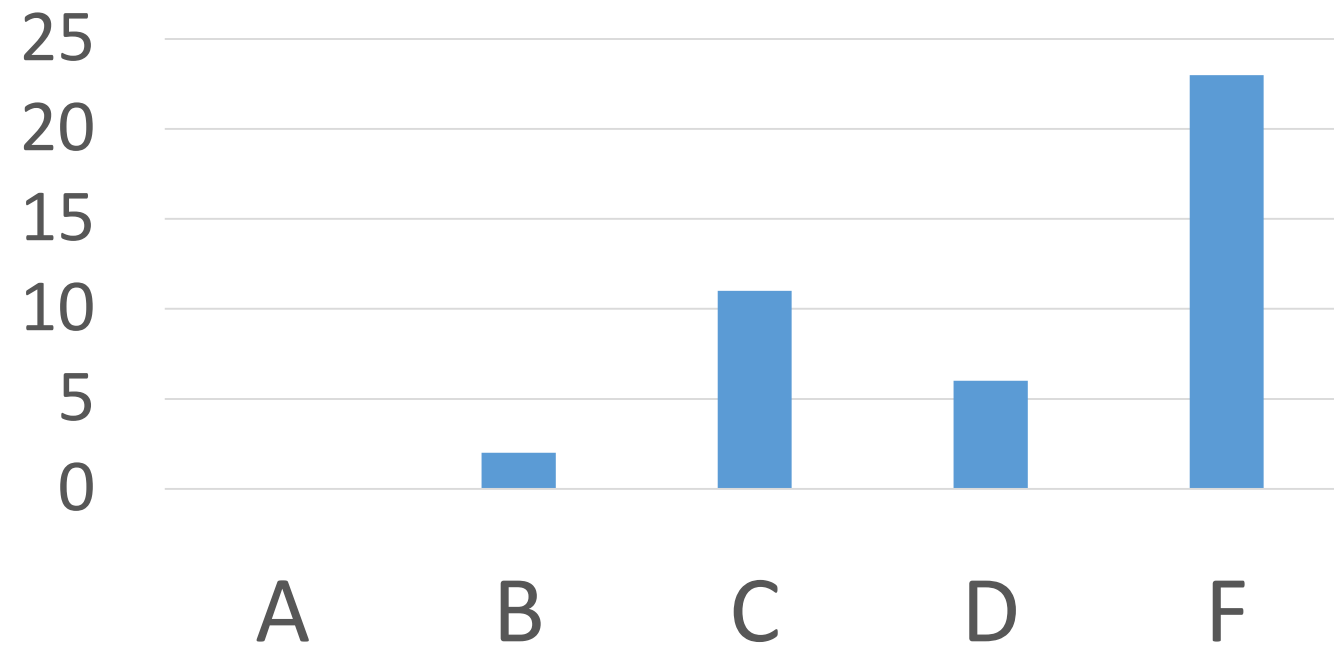
I think about my thinking!



- I'm thinking...
- I'm noticing...
- I'm wondering....
- I'm seeing....
- I'm feeling...



EXAM



- How are exams created
- Learning from exam



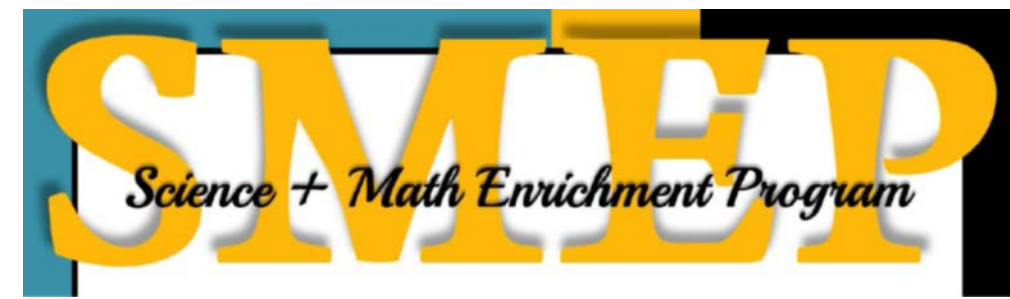
MINDSET RECAP

	FIXED MINDSET THINKING	GROWTH MINDSET THINKING *
ACHIEVEMENT...	means proving you're smart.	means that you're learning and stretching.
BEING SMART...	means that you're making no mistakes.	means that you're confronting a challenge and making progress.
A SETBACK OR MISTAKE...	leads to loss of confidence.	indicates an area for growth.
FAILURE...	leads to humiliation.	means that you're not yet fulfilling potential.
EFFORT...	shouldn't be required if you're smart and takes away excuses for failure.	is the path to mastery that makes you smarter. You get out what you put in.
SUCCESS...	is defined as being the best and is based on talent.	is defined as working hard to become your best and is based on motivation.
A BAD GRADE...	means it's time to give up.	means it's time to work harder.
FEEDBACK...	is threatening, as it provides good or bad news about precious traits.	is welcomed, as it provides useful direction toward areas to work on.
THE NEED TO ASK FOR HELP...	indicates a weakness or deficiency which should not be admitted.	is a useful strategy for growth.
STEREOTYPE THREAT...	is high due to fears of confirming negative stereotype.	is low; a stereotype is simply someone else's inaccurate view of their abilities.
TALENTED PEERS...	become grounds for feeling threatened and jealous.	are a source of inspiration.

PRACTICING MINDSET

The desire to look
smart.

A: Growth B: Fixed

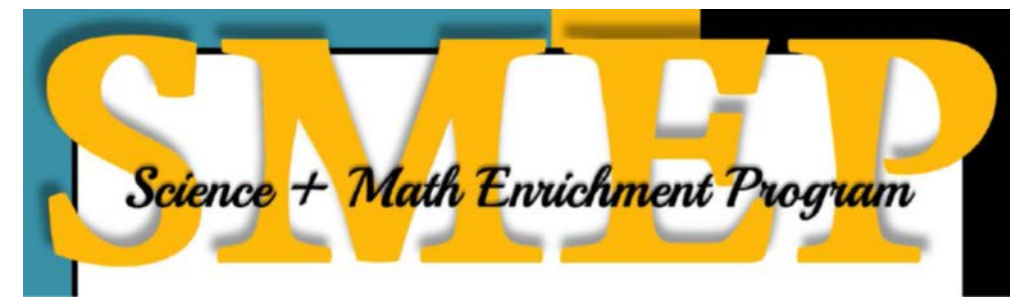


PRACTICING MINDSET

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

A: Growth B: Fixed

#smepCSULB



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



FRESHMEN SCHOLARS

LEARNING COMMUNITY

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.

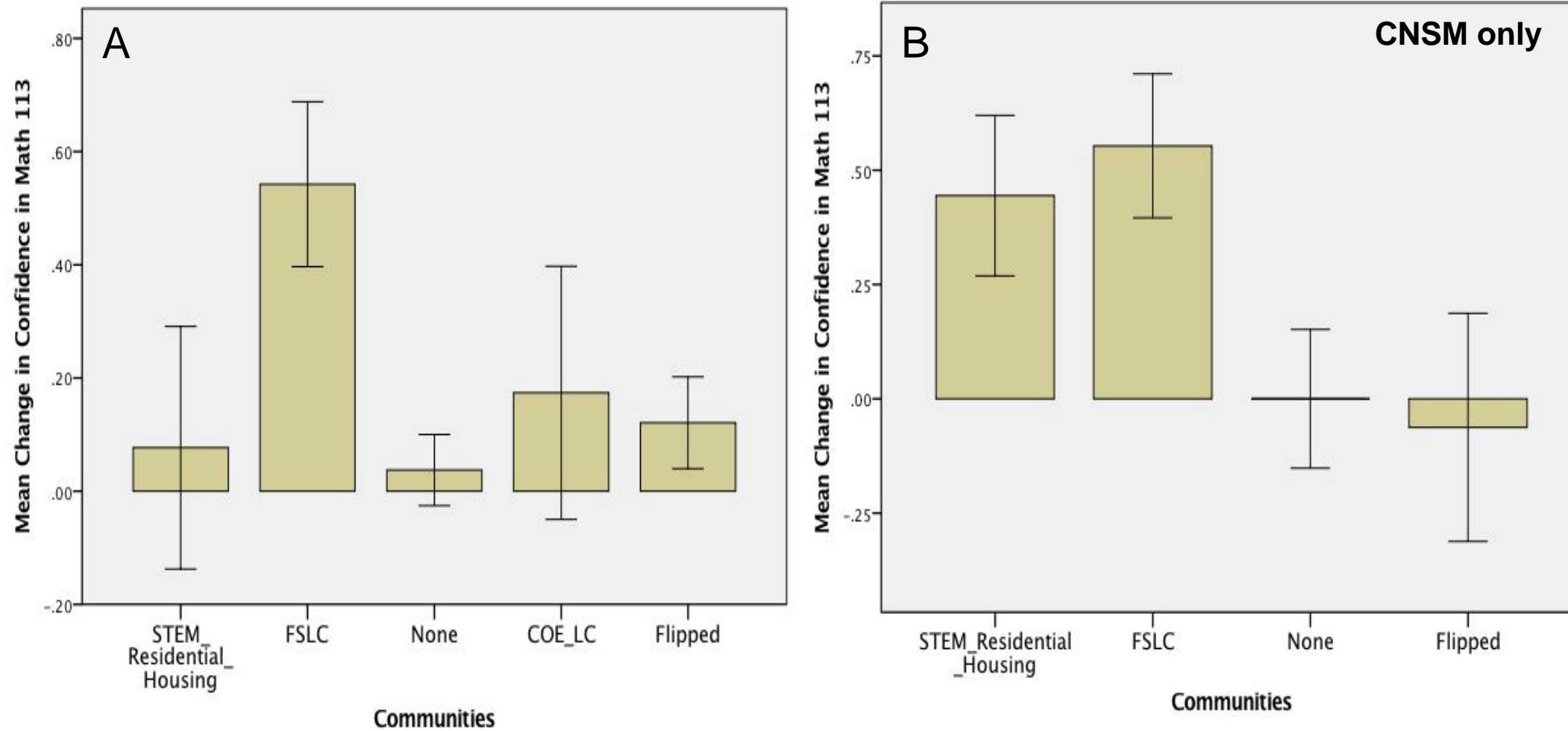


CHEMISTRY CLASS / MATH CLASS / SUPPLEMENTAL INSTRUCTION / SCIENCE SUCCESS CLASS HOMEWORK HELP HOUR WITH PEER MENTORS

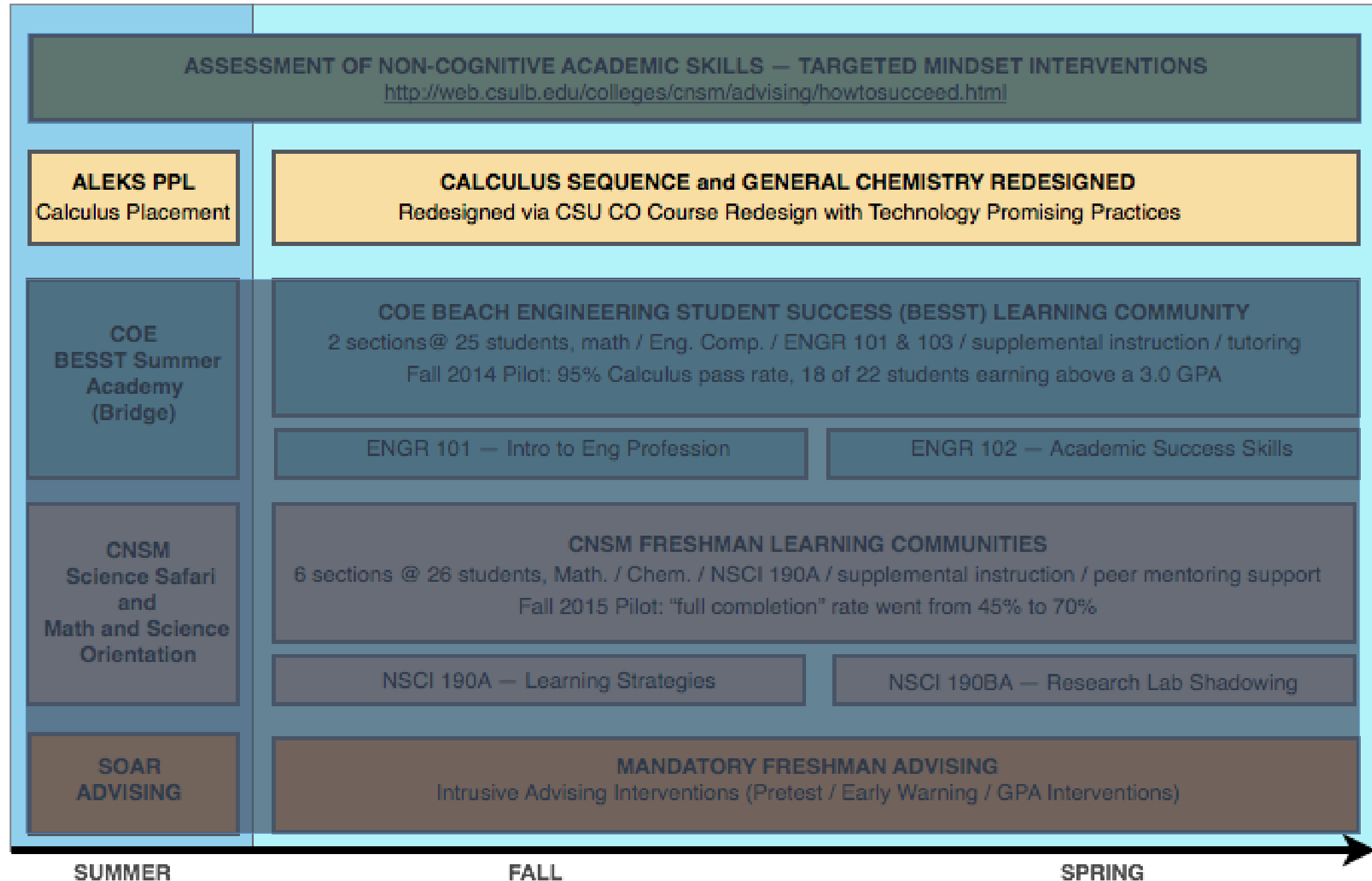
- **WELCOME EVENT**
- **NEWSLETTER**
- **MIDTERM PREPARATION**
- **INDIVIDUAL PEER MENTORING**
- **SPRING REGISTRATION PRIORITY**
- **GUARANTEED SUPPLEMENTAL INSTRUCTION**



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.



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



FRESHMAN IN FALL CALCULUS I

**CALCULUS PLACEMENT VIA ALEKS PPL FOR
ALL CSULB STEM STUDENTS
FREE OF CHARGE, TOTAL COST ~\$40k**

	% FTF	FTF PASS RATE
FALL '11	33.10%	66.40%
FALL '12	33.10%	63.40%
FALL '13	49%	65.80%
FALL '14	61.80%	73.80%
FALL '15	70.80%	72.60%
FALL '16	79.10%	



ALEKS®
Placement, Preparation and Learning



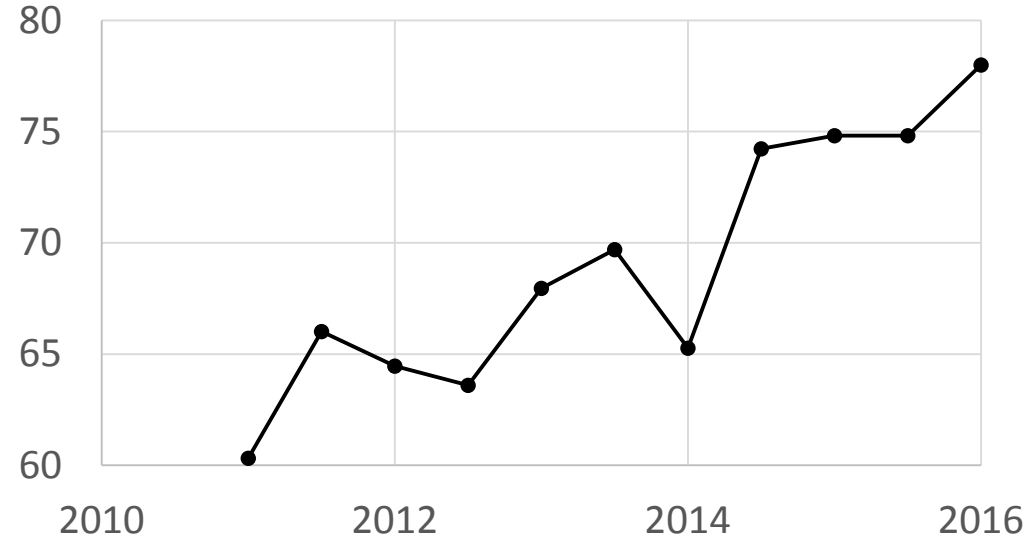
CALCULUS I and II REDESIGN

- “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 the by 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

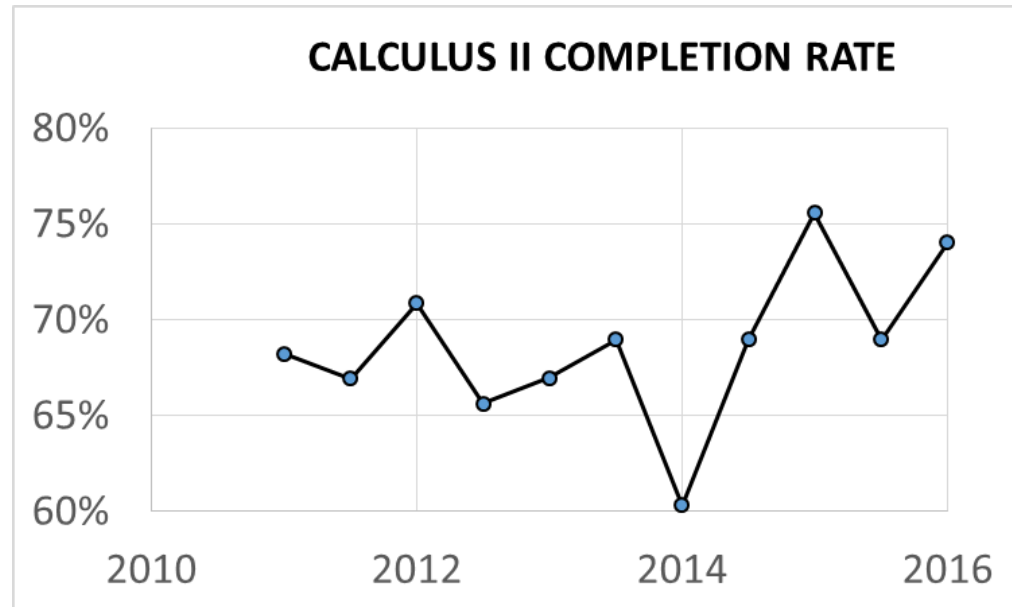


CALCULUS I and II REDESIGN

CALCULUS I COMPLETION RATE

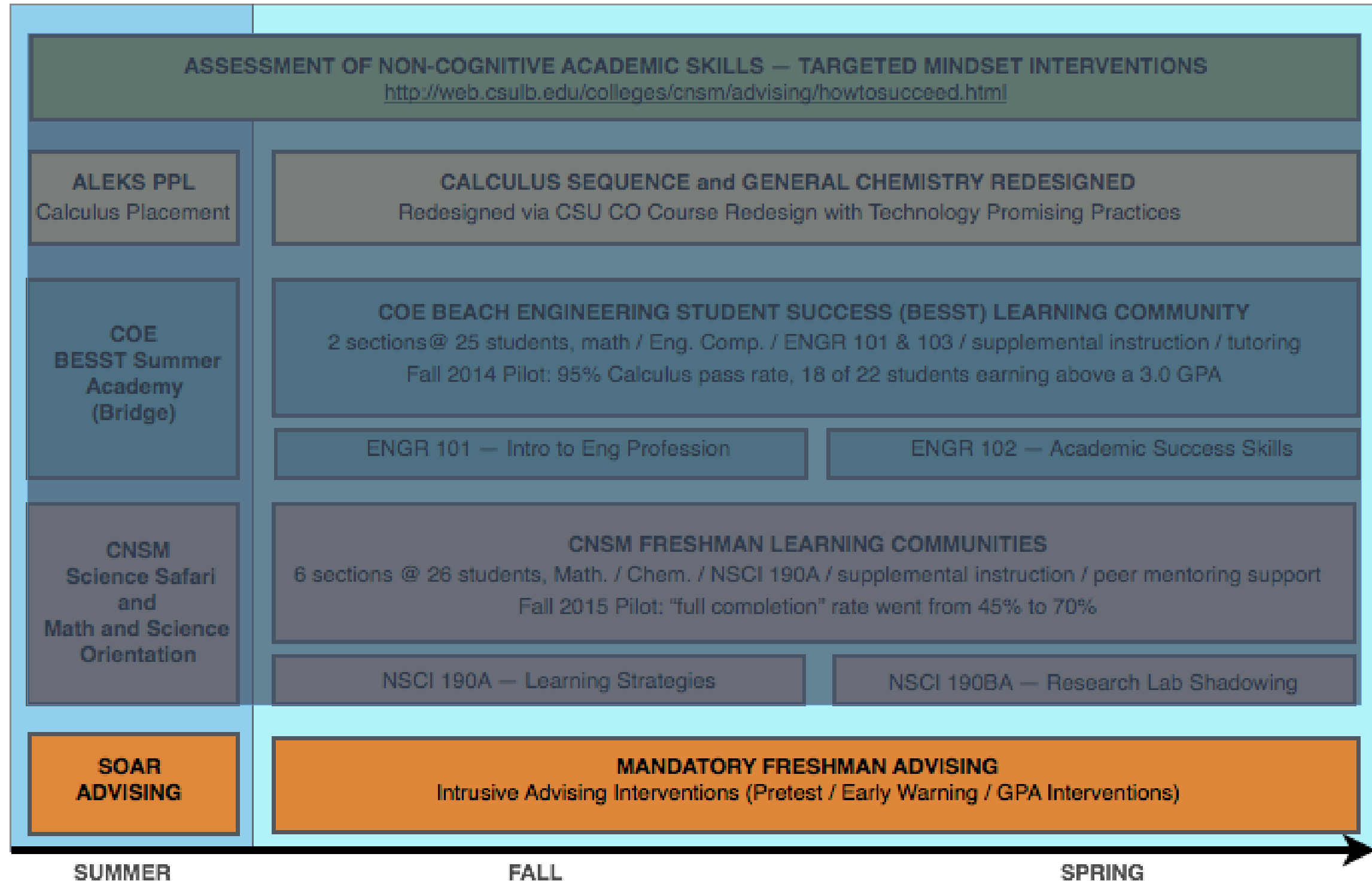


CALCULUS II COMPLETION RATE

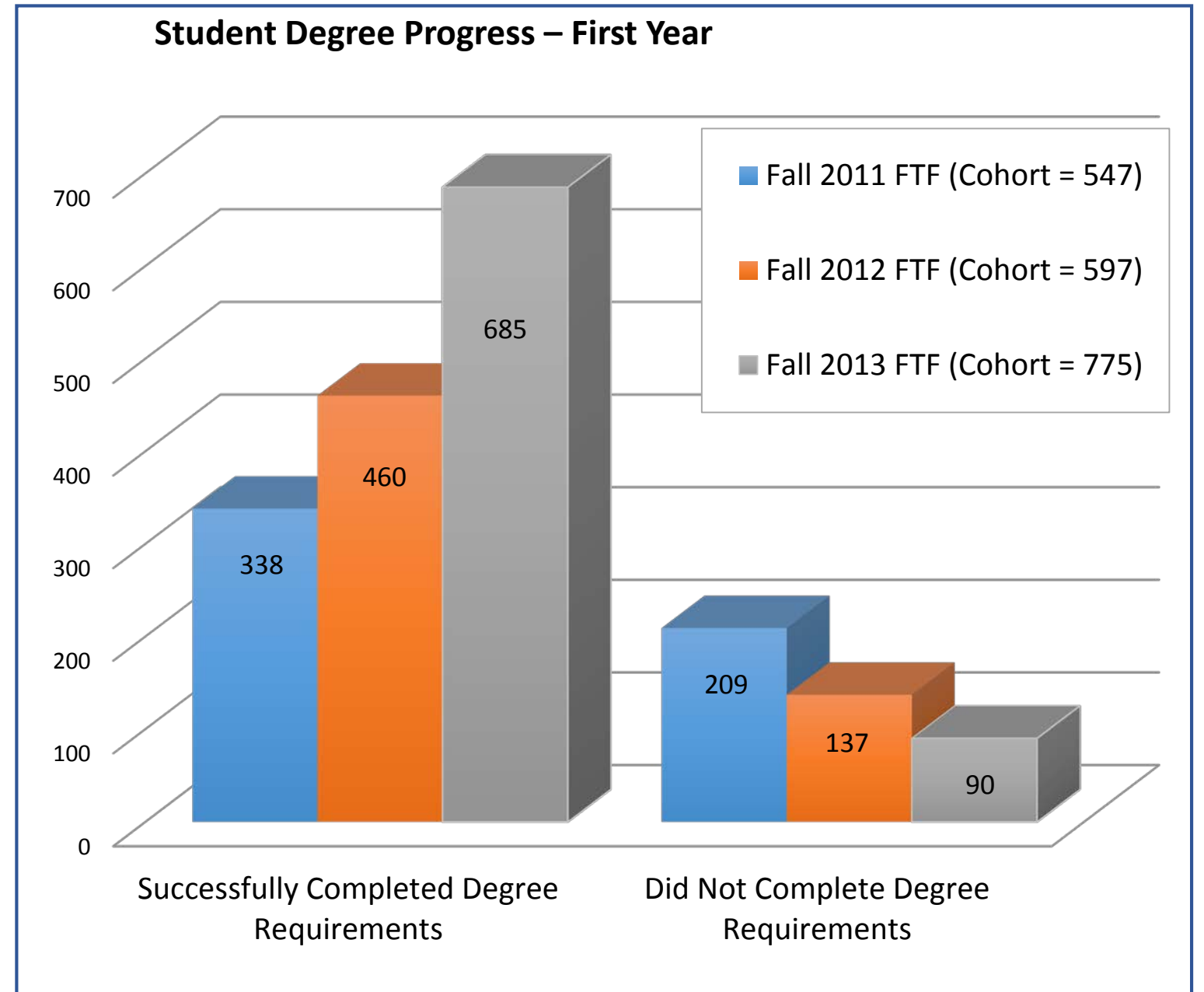


Redesigned sections compared with non-redesigned sections past and present
122 → 123 GPA change

	MATH 123 PARTICIPATING	MATH 123 NON-PARTICIPATING
MATH 122 PARTICIPATING	2.41 (-0.54)	2.28 (-0.57)
MATH 122 NON-PARTICIPATING	2.34 (-0.44)	2.18 (-0.58)



- **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



Pre-Major Requirements

COE Pre-major requirements
started in Fall 2013.

Fall 2012 (without Pre-Major):

Fully declared: 60%

Left Major: 40%

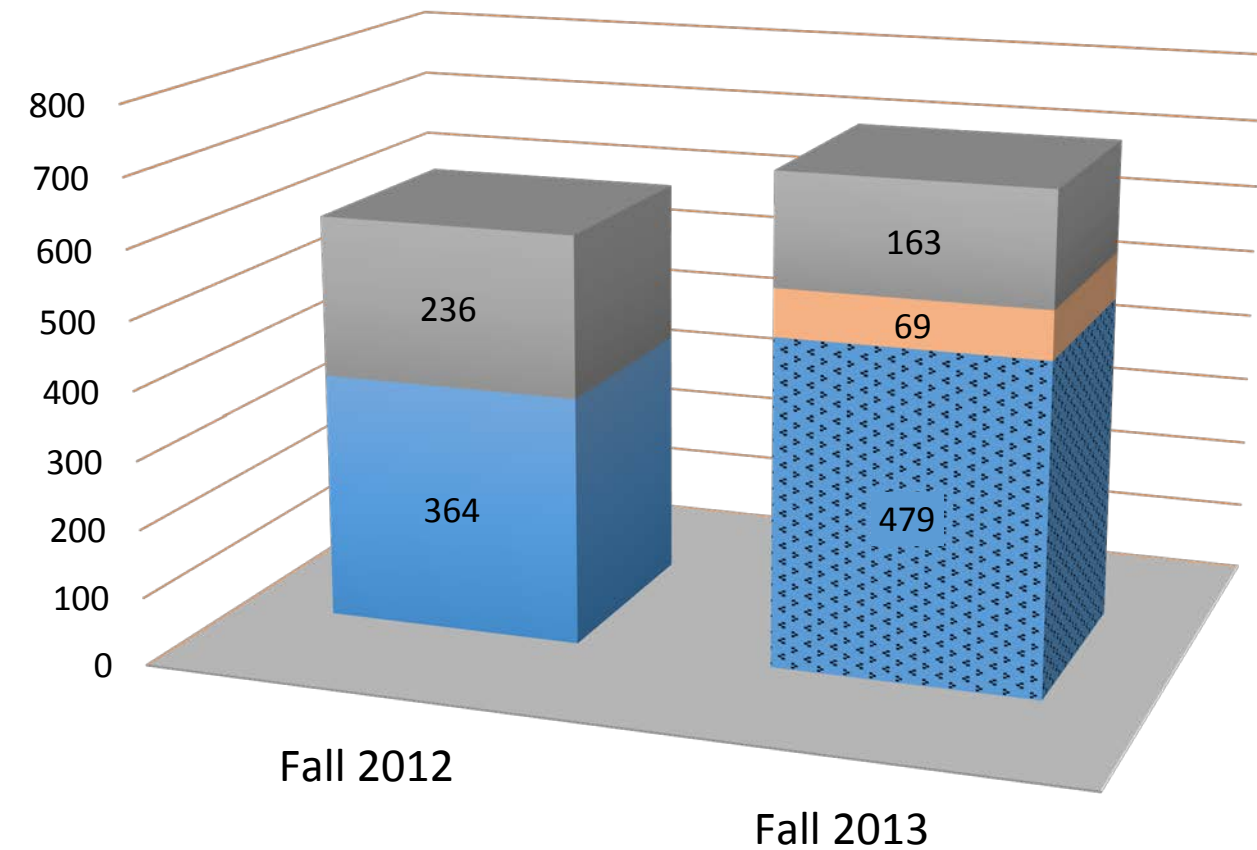
Fall 2013 (with Pre-Major):

Fully declared: 65.5%

Remaining as Pre: 12.5%

Left Major: 23%

**FTF COE - Fall 2012 (without Pre-Major) vs.
Fall 2013 (with Pre-Major)**



- Left major or CSULB
- Remaining in Pre-Engineering
- Fully declared COE majors

- CASELOAD ADVISING
- PRE-TEST IN CALCULUS AND CHEMISTRY
- MANDATORY FRESHMAN ADVISING (2)
- EARLY ALERT ADVISING

CNSM Academic Advising Structure



PRINCIPLES OF INTRUSIVE ADVISING (PRETEST, EARLY ALERT, PROBATION):

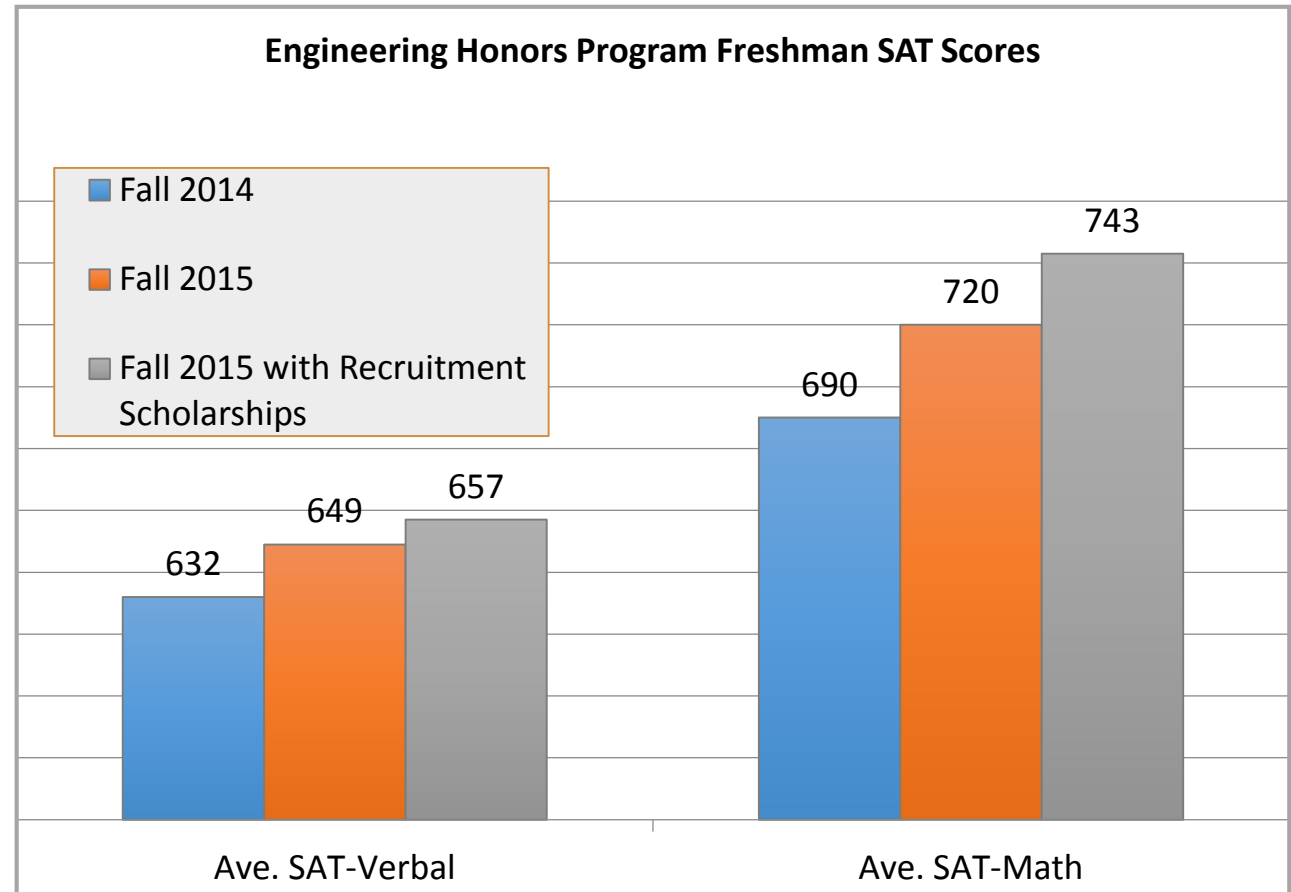
- How did the student describe the situation?
- Growth Mindset or Fixed Mindset?
- Optimistic Explanatory Style
 - Proactive and problem-focused coping strategies
 - Take initiative
 - See the lessons in failure
 - Attributes failure to controllable causes
- Guiding Questions
 - Where am I going? (possible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

- 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.

1										
2	Student ID	Course	Pre-Test CHEM	Pre-Test CHEM	Pre-Test CHEM 220A List?	Advisor	Email	Times found	2 or more times	3 or r times
3		CHEM 111B		Yes		AARC		2	2	
4		CHEM 111B		Yes		AARC		2	2	
5		MATH 113				AARC		2	2	
6		MATH 119B				Anthropology		3	3	
7		PHYS 151				Art		2	2	
8		PHYS 152				ATLAS		2	2	
9		CHEM 220A				Biology		2	2	
10		CHEM 220A			Yes	Biology		2	2	
11		BIOL 260				Biology		2	2	
12		CHEM 220A				Biology		2	2	
13		CHEM 220A			Yes	Biology		2	2	
14		CHEM 220A				Biology		2	2	
15		CHEM 220A				Biology		2	2	
16		CHEM 220A			Yes	Biology		2	2	
17		CHEM 220B				Biology		2	2	
18		BIOL 340				Biology		2	2	

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)

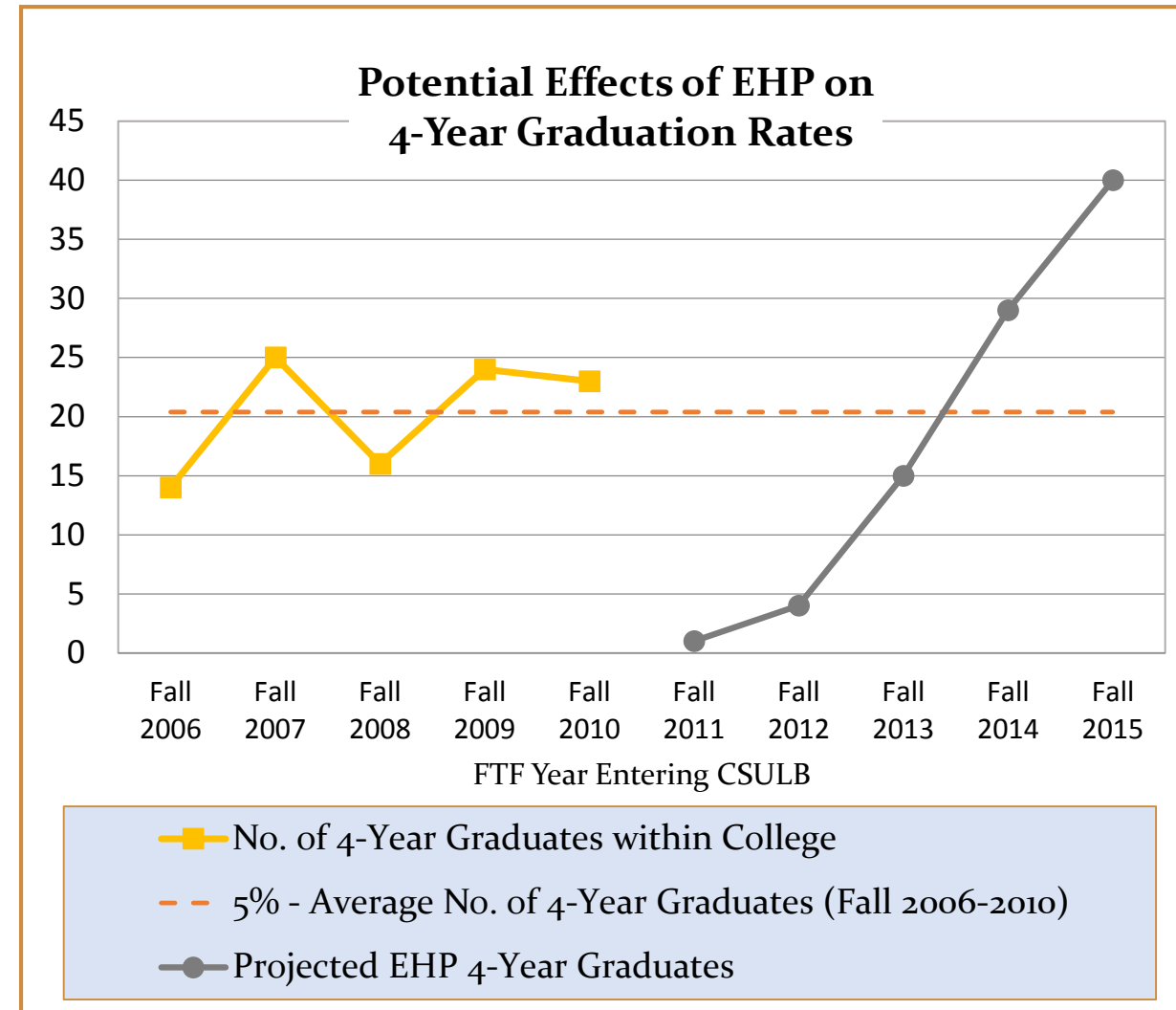
ENGINEERING: 4-Year Graduation Rates

4-year graduation rates have been flat:

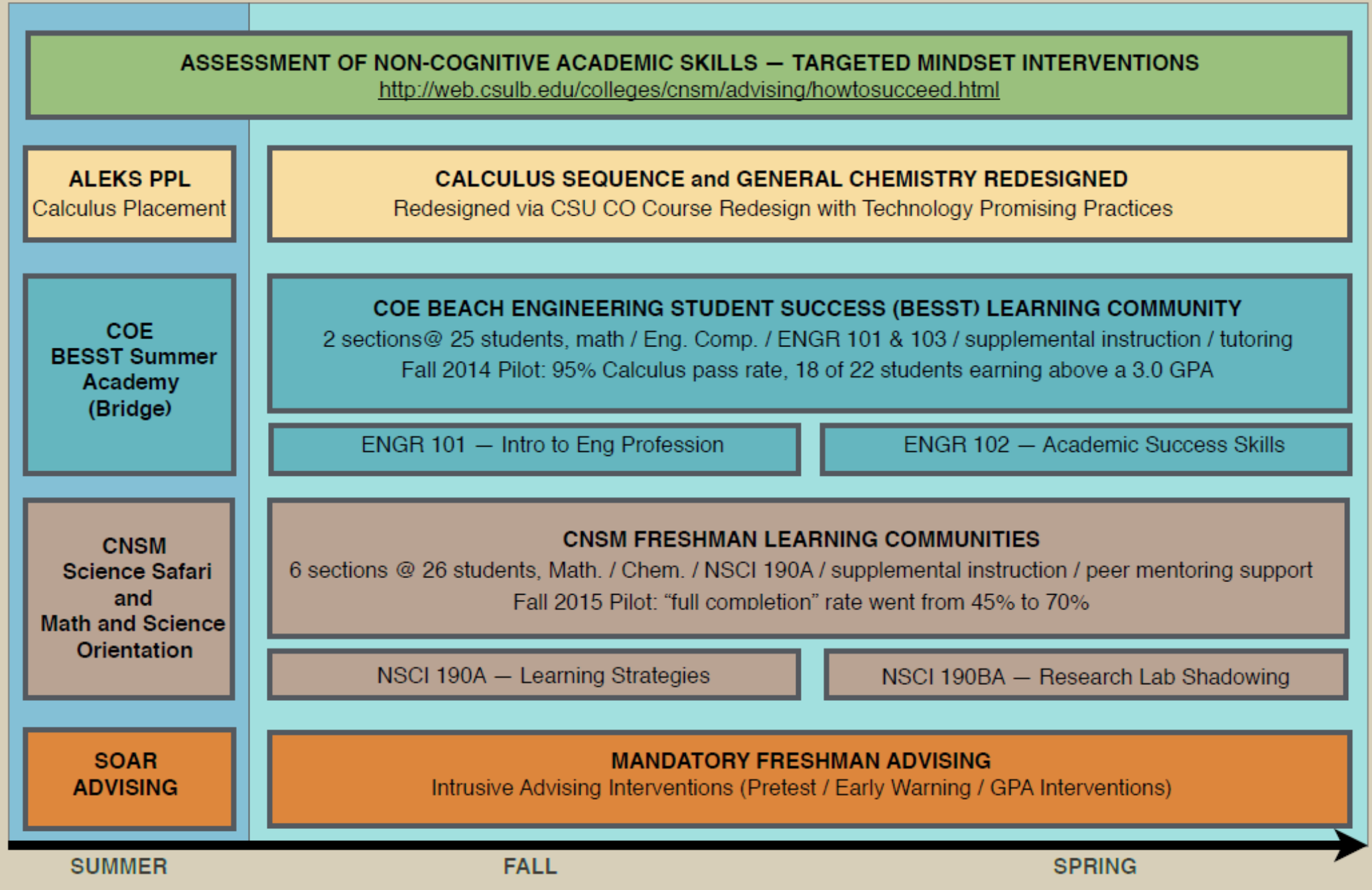
- averaging 5.3% from Fall 2006 to Fall 2010
- On average, 20 FTF per year have graduated in 4-years

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





The California State University

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THE TRAIN UGLY

MANIFESTO



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

