Supporting Equity Goals in Chemistry

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Overview of Work

- Literature review on chemistry Curriculum and Classroom strategies shown to increase success
- Research on other programs helping target students in STEM
- Research on conferences and workshops
- Implementation and trial of a few strategies over the 16-17 year and our findings
- Institutional Research of Chem 25/1A/1B students (In Progress)
- What can we do now? What are next steps?

Factors contributing to lack of student success in Chemistry

- Perceptions of an unwelcoming academic culture in science and math departments
  - Takes much less to dissuade marginalized students from STEM Pathway (Toven-Lindsey, 2015)
- Studying in isolation and inability to get help (Towns 2000, Treisman 1992)
- Unfamiliarity with college culture and expectations
- Financial need and time spent on school
- Less prepared → Lower level mathematics completed
  - Mathematics level completed was a very strong determinant for success (Mason, 2001; Tai, 2005)

Chemistry Curriculum Strategies

- Active learning! In introductory courses has shown to increase success rates. (Freeman 2014)
- Small-group learning activities developed a ***feeling of community*** in the classroom. (Towns 2000)
- Challenging yet emotionally supportive environment
- Encourage higher level thinking and conceptual understanding over process tasks
- Align curriculum with threshold concepts that encourage critical thinking and analysis
- Offer extra assessment and discussion time
- Strategies around problem solving skills, metacognition, concept building

HSI and NSF Grants

Survey of Local Hispanic Serving Institutions, and NSF STEM retention grants

1. Establishment or improvement of STEM Center
2. Implementation of peer-led tutoring groups
3. Development of Summer Bridge Program or Workshops
4. Mentoring program with faculty members
5. Internships with Corporate Partners to broaden a student's perspective of STEM careers

What are other schools/programs doing?

- Santa Monica College: Chemistry Boot Camps
  - Weekly boot camps facilitated by peer tutors
  - Book Camp sessions: Saturdays 1:00-4:30 PM
- UCSC: ACE Program
  - Two 90 minute discussion sessions that focuses on group learning
  - Weekly meetings with Peer Mentors, Review Sessions before every exam, and academic contracts if grade is below average
- Rutgers: Solid GEMS Chemistry Summer Program
  - 10-week residential program for incoming freshman
  - Intensive daily study of Chemistry
  - 4 units for General Chemistry

Equity Research Questions:

Study the Chem 25/1a/1b pipeline to improve retention and understand our student population.

1. How does a students' letter grade in Chem 25 (or Chem 1A) correlate with their grade in Chem 1A (or Chem 1B)?
2. If a student does not pass Chem 25 (or Chem 1A) how many times do students repeat before passing? Or do they never take the course again?
3. Of the students who do pass Chem 25, how many do not enroll in Chem 1A?

What have we tried in the classroom?

- Sandhya (Chem 1A, 1B)
  - Targeted worksheets with "study sessions" directly after each lecture
  - Use of embedded tutor
  - Reading apprenticeship strategies (in Lab)
  - Specific tailored guidance on what to do after each lecture (Clear and explicit guidelines and communication)
  - Connecting students to campus resources (i.e. STEM center)

What have we tried in the classroom?

- Rosa (Chem 1A, Chem 30A)
  - FTLA: Syllabus redesign, Growth Mindset, Culturally Relevant Teaching
  - Embedded tutor, set up study groups at STEM center
  - Active Learning assignments in lecture tied to attendance
  - Financial Aid presentation, Tour of Foundations Lab and TLC
  - Weekly Newsletters with Book and Video Resources
- Chemistry department
  - Diagnostic Exams
  - Atoms First Curriculum
  - Invite vendors to demonstrate learning platforms

What are our next steps?

- Encourage an inclusive atmosphere and community with collaboration and active learning
- Think of interventions within the structure of the classroom (many have limitations on their time outside of the classroom)
- Integrate with established programs on campus: STEM Core, STEM Center, Embedded Tutor Program, Math Summer Bridge, UMOJA, PUENTE
- Encourage faculty to teach 2 classes in sequence (Chem 25 to Chem 1A, or Chem 1A to Chem 1B) to build community
- Encourage discussion amongst faculty regarding student learning outcomes and threshold concepts.
- **Offer training and support to other faculty in our department.**
- **Innovate! We want to come up with new ideas and are open to suggestions.**

Professional Development and Conferences

- **Professional Development**

  Foothill: Peer to Peer Faculty Exchange, Reflective Writing Challenge, FTLA

  Districtwide: Teaching and Learning Workshops For Faculty

- **Conferences**

  The RP Group, Strengthening Student Success Conference, Oct 2017

  ChemEd 2017 Conference, July 2017

  ConfChem Online Conference, Mathematics in First-Year Chemistry Instruction, Fall 2017

- **Become a student! Taking classes can give you some insight into what type of student or teacher you are.**

Inclusive Classroom Climate

- Make effort to learn names and meet every student
- Pass out a questionnaire to learn about your students
- Talk about your own experiences so students can get to know your better
- Foster an inclusive atmosphere: “Welcome chemists” or “Welcome Scientists”
- Provide an supportive classroom climate: Email students when absent
- Show examples related to their lives
- Include stories of scientists from underrepresented groups
- Be very specific in communicating expectations and give clear study guidelines (don’t assume they “know” how to study)

Active Learning in Chemistry Classroom

- Reading Apprenticeship: Pause Procedure, Problem solving in lecture using RA techniques
- Collaborative Learning in Lecture: Use low or no-stakes assessment to practice Think-Pair-Share, Driver-Navigator Paired Placements
- Cooperative Learning in Lab: Assign partners and switch partners each lab
- Encourage Student Feedback: Clearest Skies or Muddiest Point
- Technology in Classroom: Pearson Learning Catalytics, McGraw Hill LearnSmart

Methodology of Project

- Looked at journal articles (Journal of Chemical Education, JACS) focused on curriculum and classroom
- Researched local universities and community colleges
- Researched nationwide Hispanic serving institutions and NSF funded grants
- Worked with Institutional Research to gain deeper understanding of student population
- Research pathways for STEM student in 2-year and 4-year institutions

Chemistry Department Success Rates 2015-2016

Overall: 66% vs 51% **-15% Gap** (22.4% 4-year increase enrollment target)
Transfer Level Chem
Chem 1A: 59% vs 39% **-20% Gap**
(154 target students enrolled, 43.7% 4-year increase enrollment target)
Chem 1B: 66% vs 53% -13% Gap
Chem 1C: 89% vs 77% -12% Gap
Chem 12A: 69% vs 71% (17 target students enrolled, where did they all go?)
Chem 12B: 77% vs 62% -15% Gap
Chem 12C: 94% vs 100% (9 students enrolled)
Intro and Allied Health
Chem 25: 65% vs 45% **-20% Gap** (53% 4-year increase enrollment target)
Chem 30A: 61% vs 51% -10% Gap (47% 4-year increase enrollment target)
Chem 30B: 79% vs 71% -8% Gap

Other Department Success Rates 2015-2016

Transfer Level Chem
Chem 1A: 59% vs 39% **-20% Gap**
Transfer Level Math
Math 1A: 59% vs 43% -16% Gap
Transfer Level Biology
Bio 1A: 80% vs 68% -12% Gap
Intro and Allied Health
Chem 30A: 61% vs 51% -10% Gap
Bio 40A: 77% vs 69% -8% Gap

SAGE Project: Hall, 2014, J. Chem. Ed.

- Followed cohort through first 2 years of science courses.
- Learner centered pedagogies: Peer-led team learning, guided-inquiry learning, student-centered activities, supplemental instruction
- Six critical components:
  1. Study groups (collaboration)
  2. SAGE program developer taught or coordinated courses (facilitator)
  3. TA were trained in small-group and collaborative learning (training)
  4. Problems were challenging (assessment)
  5. Study groups were in rooms outfitted for group learning (environment)
  6. Institutional and department support. (outside support)

Threshold Concepts: Talanquer, 2015, J. Chem Ed.

Cognitive portals to new and previously inaccessible ways of thinking in a domain.

Transformative: Their understanding causes a signifi- cant shift in perspective and ways of thinking about a subject.

Integrative: Their understanding brings together various concepts and ideas.

Irreversible: Once understood, the concepts become central to the ways of thinking of an individual and are unlikely to be forgotten.

Troublesome: Many threshold concepts seem counterintuitive and are difficult to understand.

Bounded: Many threshold concepts are specific to a discipline.

"Atomicity"; "Chemical Bonding"; "Intermolecular Forces"; and "Chemical Equilibrium"

Chemistry Strategies – outside of classroom

- Learning communities/cohort based learning
- This study reveals that students can improve their achievement by forming smaller collaborative learning groups and participating in tutorial sessions.
- Summer Bridge
- Diagnostic exams with targeted tutorials (Londa?)