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Collegiate Active Learning Calculus Survey (CALCS): Adapting an instrument and using results

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Abstract for DBER Group Discussion on 2016-10-27

Presenter(s), Department(s):
Wendy Smith
Assistant Director, Center for Science, Mathematics and Computer Education
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University of Nebraska-Lincoln

Title:
Collegiate Active Learning Calculus Survey (CALCS): Adapting an instrument and using results

Abstract:
When we make changes to a course, we want to know if they "worked." There is often a desire to broaden the definition of success beyond student (passing) grades. We know from research that the further students go in mathematics, their attitudes toward and beliefs about mathematics get more and more negative. Thus, if we slow or even reverse that trend, we might then claim success for our reform efforts. Research teams at the University of Colorado Boulder created the CLASS: Colorado Learning Attitudes about Science Survey; this was originally designed for undergraduate physics, then later adapted for use with mathematics, biology, and chemistry. More recently, our research team has revised and adapted this instrument to create CALCS: Collegiate Active Learning Calculus Survey. I will discuss both methodology (how we went about revising the instrument) and results (how we are learning about student attitudes toward mathematics).

Collegiate Active Learning Calculus Survey (CALCS): Adapting an Instrument and Using Results

Wendy M. Smith
Presentation to UNL DBER Seminar
October 27, 2016

Student Engagement in Mathematics through an Institutional Network for Active Learning

SEMINAL

Association of Public & Land-Grant Universities

University of Colorado Boulder

NEBRASKA
UNIVERSITY OF NEBRASKA-LINCOLN

San Diego State University

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All findings and opinions are those of the authors and not necessarily of the NSF.

What is the Problem?

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- Average of 25% DFW at R1 institutions in Calculus
- Failing math correlates highly with freshman dropouts
- Beliefs about & attitudes toward mathematics K-20 follow a decreasing trajectory (Grover, 2015)
- After freshman year, students switch away from STEM majors (9-25%)

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- 67% of UNL freshmen enroll in math in their first semester
  - No other dept. garners even half that
- Initial UNL efforts: Math 101 & 103 (precalculus) then Math 100A (intermediate algebra), 102 (trig)
- DFW rates dropped from 40% to a stable 20% in precalculus
- Efforts now being extended to calculus courses (Math 104, 106, 107)

Undergrads in active learning environments can learn more effectively, resulting in increased achievement and improved dispositions (Freeman et al., 2014; Laursen et al., 2014; Rasmussen & Kwon, 2007), <u>particularly for underrepresented groups</u> (Laursen et al., 2011).

Student Engagement in Mathematics through an Institutional Network for Active Learning

ASSOCIATION OF PUBLIC & LAND-GRANT UNIVERSITIES

SEMINAL

University of Colorado Boulder

NEBRASKA
UNIVERSITY OF NEBRASKA-LINCOLN

SAN DIEGO STATE UNIVERSITY

Goal: better understand how to enact and support institutional change aimed at implementing active learning in undergraduate mathematics learning environments

Collaborative Research: NSF I-USE Grant

- 5-year, $3 million, 2016-2020
- APLU (Association of Public and Land-grant Universities (Howard Gobstein)
- University of Colorado Boulder (David Webb, Rob Tubbs, David Grant)
- University of Nebraska-Lincoln (Wendy Smith, Allan Donsig, Nathan Wakefield)
- San Diego State University (Chris Rasmussen, Michael O'Sullivan, Janet Bowers)

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SEMINAL Research

University of Nebraska Lincoln

<u>Primary Research Question</u>: What conditions, strategies, interventions and actions at the departmental and classroom levels contribute to the initiation, implementation, and institutional sustainability of active learning in the undergraduate calculus sequence (Precalculus through Calculus 2—P2C2) across varied institutions?

- <u>Phase 1</u>: 6 Retrospective Case Studies
- <u>Phase 2</u>: 9 Transformation Case Studies

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SEMINAL Approach: Comprehensive

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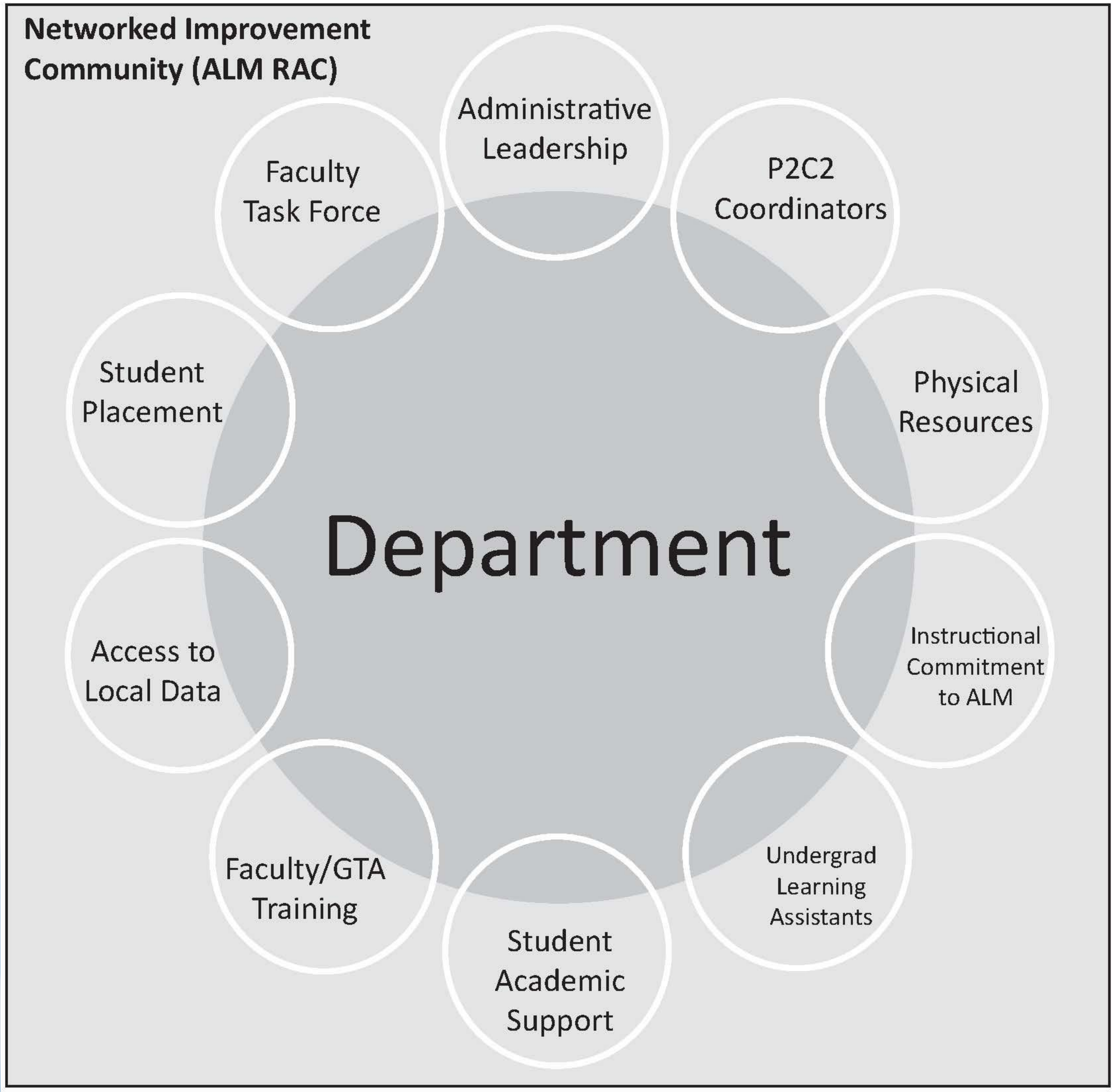

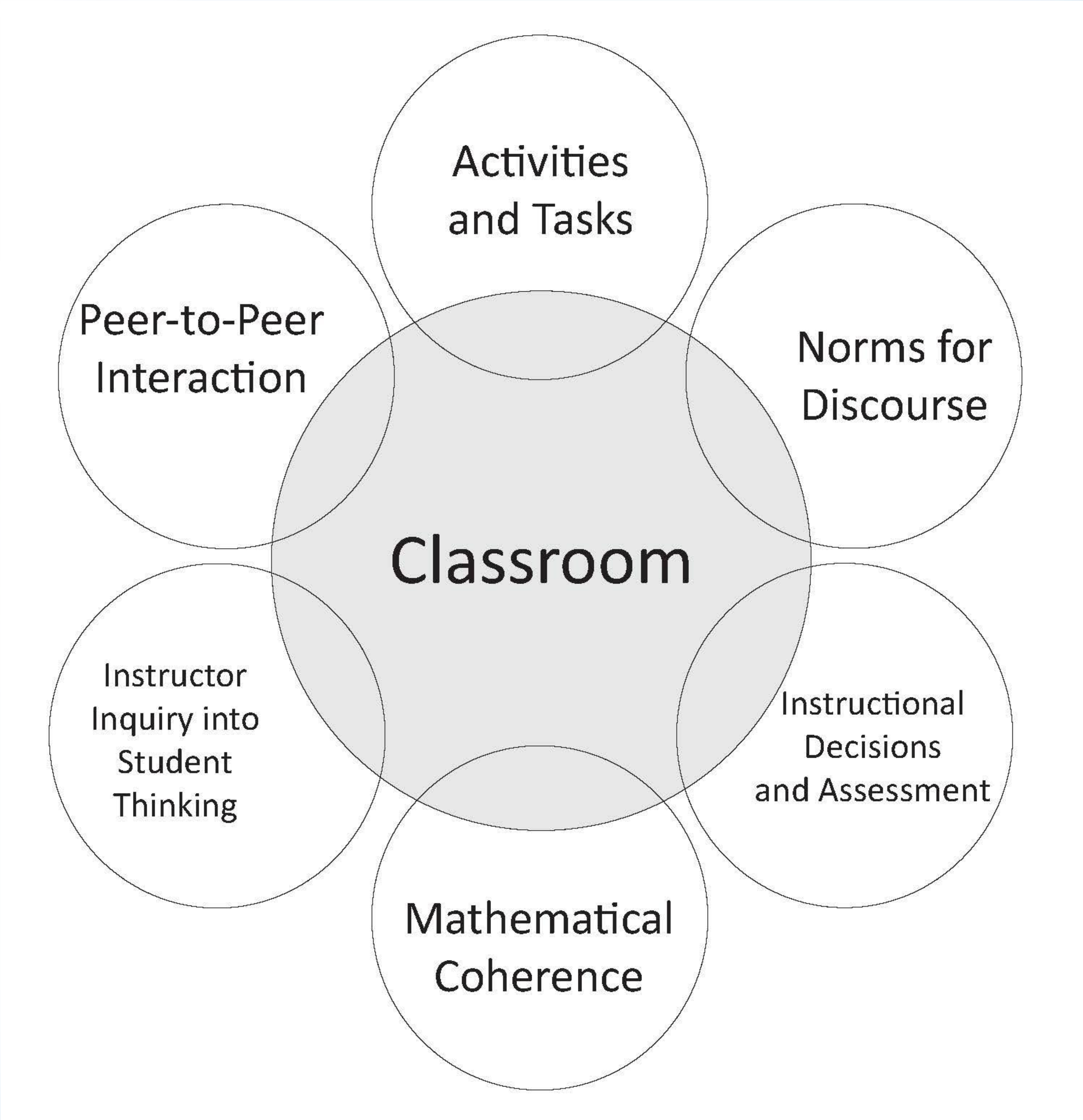

Understanding Our Students

University of Nebraska Lincoln

- Key to successful implementation of active learning
- Survey: usefulness of, beliefs about & orientation toward mathematics and active learning
  - Students need incentive to complete survey
- Also collect student grades, demographics, course-taking trajectories; focus-group interviews; course observations

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CLASS
Colorado Learning Attitudes About Science Survey

- Created for undergrad physics; adapted for math, biology, chemistry
- 41 items to measure beliefs & attitudes
- 5-point scale (strongly agree to strongly disagree)
- Original factor structure: 28 items loaded onto 8 factors
  - allowed items to load onto multiple factors
  - Personal interest
  - Real world connection
  - Problem solving general
  - Problem solving sophistication
  - Problem solving confidence
  - Sense making/effort
  - Conceptual understanding
  - Applied conceptual understanding
- 5 “neutral” items

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CALCS
Collegiate Active Learning Calculus Survey

Nebraska Lincoln

- Exploratory factor analysis on 35 CLASS items; 2014 UNL precalculus data
  - 4 factors are indicated (min=2, max=8)
  - 1 factor had only 3 items which didn't fit conceptually, so was dropped
  - 3-factor solution with 21 items:
    - Non-productive beliefs about mathematics
    - Usefulness of mathematics
    - Flexible orientation toward mathematics
- Confirmatory factor analysis on CLASS items; 2015 UNL, UNO, Colorado Boulder, West Virginia U, Auburn, San Diego St precalculus & calculus
- For 2016, piloted an added scale of 10 new items: active learning beliefs

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CALCS Factors & Sample Items

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Usefulness of Mathematics

3. I think about the math in my everyday life.

14. I study math to learn knowledge that will be useful in my life outside of school.

26. Mathematical formulas express meaningful relationships among variables.

Non-Productive Beliefs about Mathematics

1. A significant problem in learning math is being able to memorize all the information I need to know.

6. Knowledge in math consists of many disconnected topics.

23. In doing a math problem, if my calculation gives a result very different from what I'd expect, I'd trust the calculation rather than going back through the problem.

Flexible Orientation toward Mathematics

36. There are times I solve a math problem more than one way to help my understanding.

41. When studying math, I relate the important information to what I already know rather than just memorizing it the way it is presented.

11. I am not satisfied until I understand why something works the way it does.

Active Learning Mathematics

42. I can learn from hearing other people's mathematical thinking, even if their thinking is not correct.

17. Understanding math basically means being able to communicate your reasoning with others.

43. When a question is left unanswered in math class, I continue to think about it afterward.

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UNL Results

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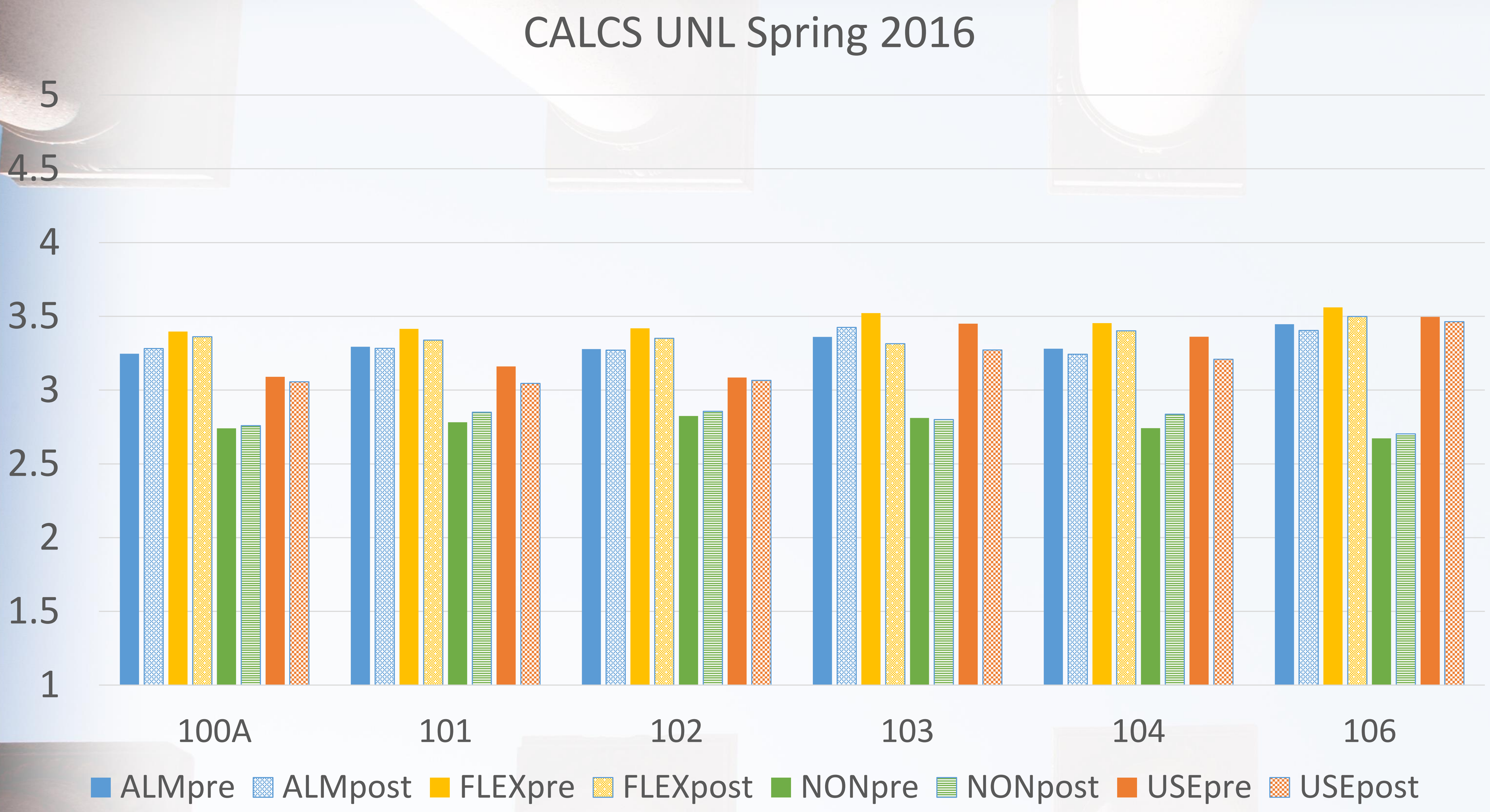

- Pre-Post changes are not statistically significant (victory!)
- Math 103 & 106 (precal and calc 1) students see math as more useful than precalculus students
- CFA continues to show items work well as factors in the survey

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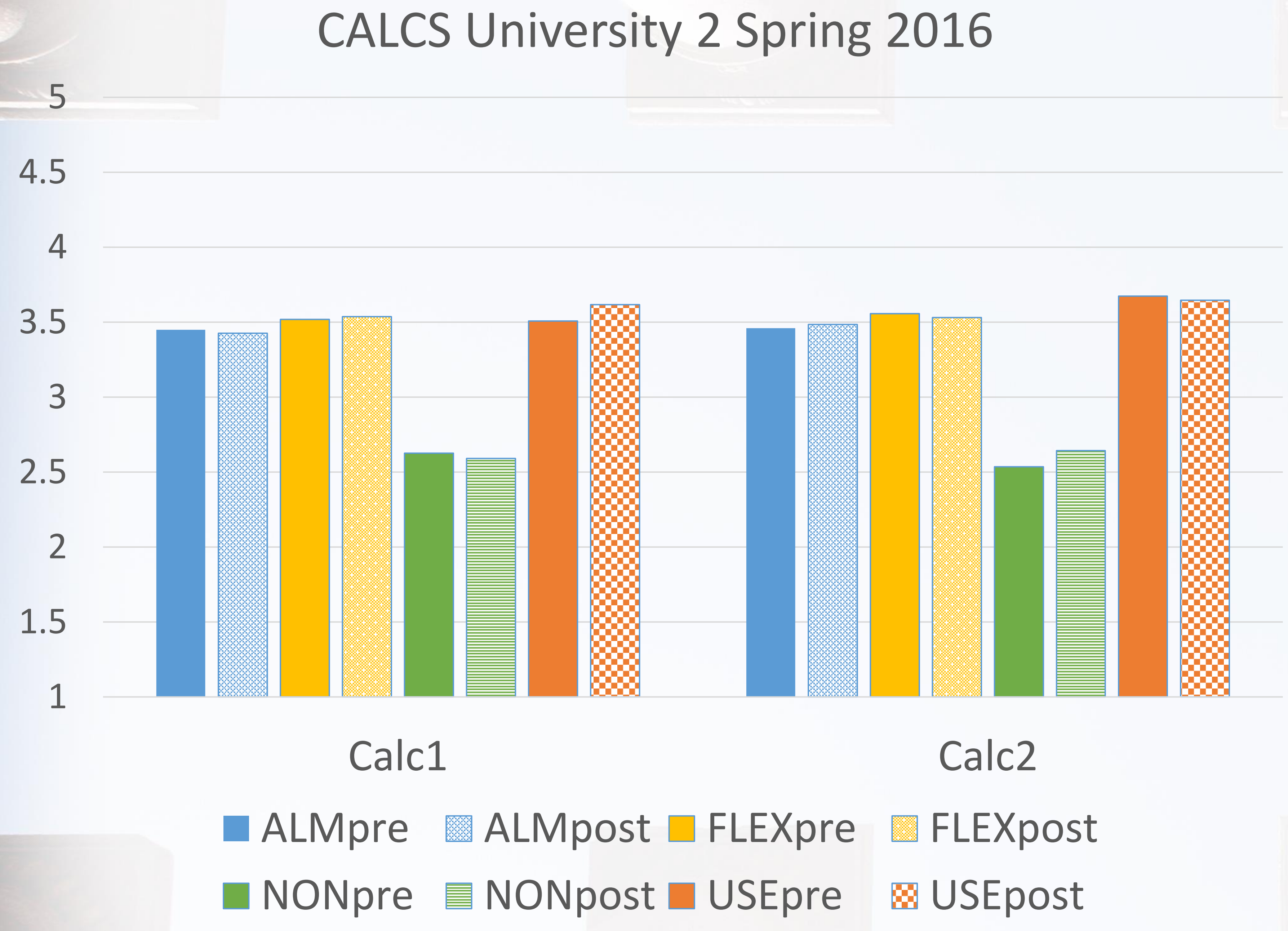
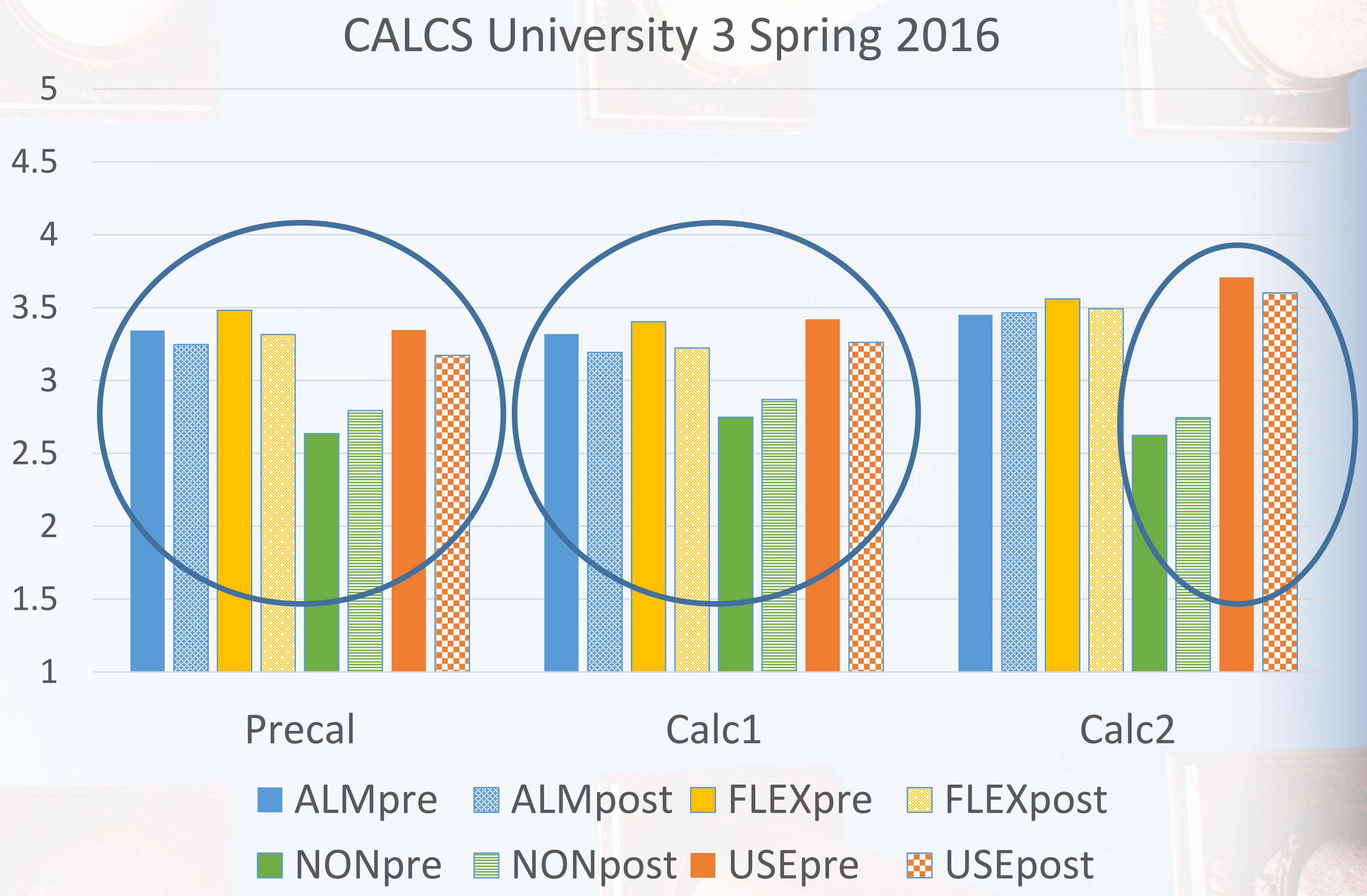
Other Results





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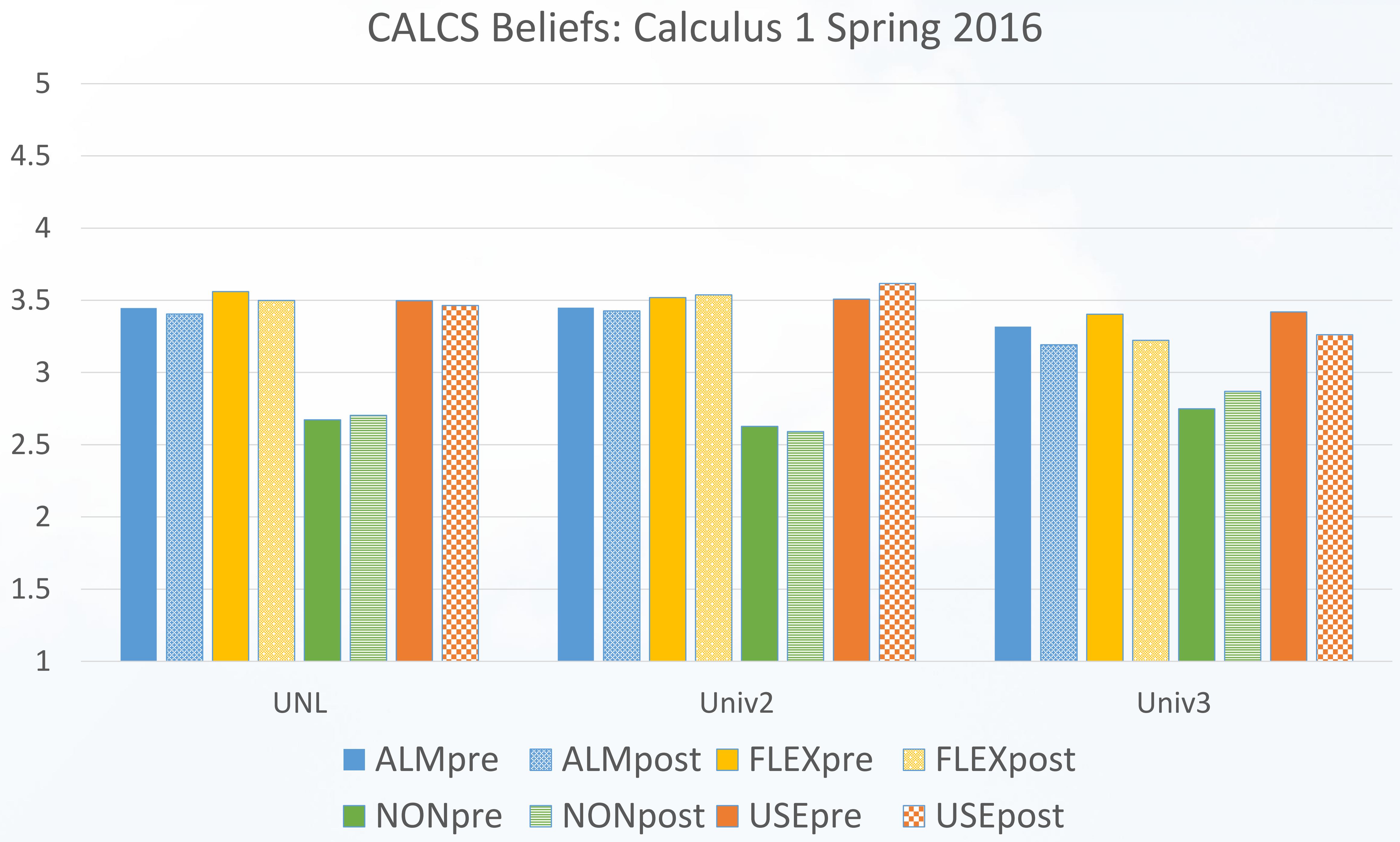
CALCS: Calculus 1



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CALCS: Active Learning Experiences

Added items piloted in spring 2016

35. I spent the majority of my time in math class this semester listening to the instructor's lecture and/or watching the instructor solve problems on the board.

36. I spent the majority of my time in math class this semester working with other students.

37. I spent the majority of my time in math class this semester working on math problems individually.

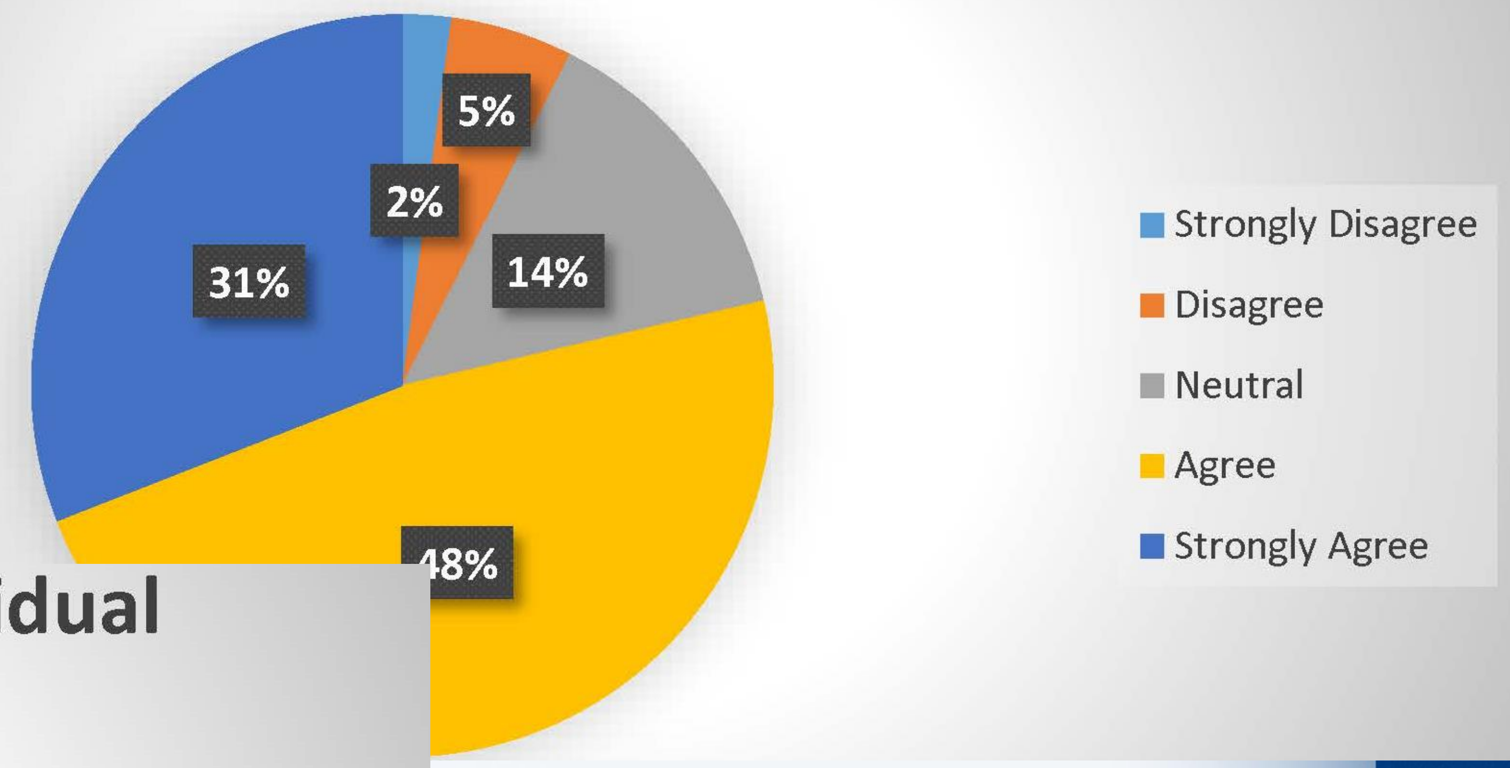
38. This semester in math class, I had opportunities to discuss math with classmates.

39. Attending class and participating regularly enhanced my performance in math this semester.

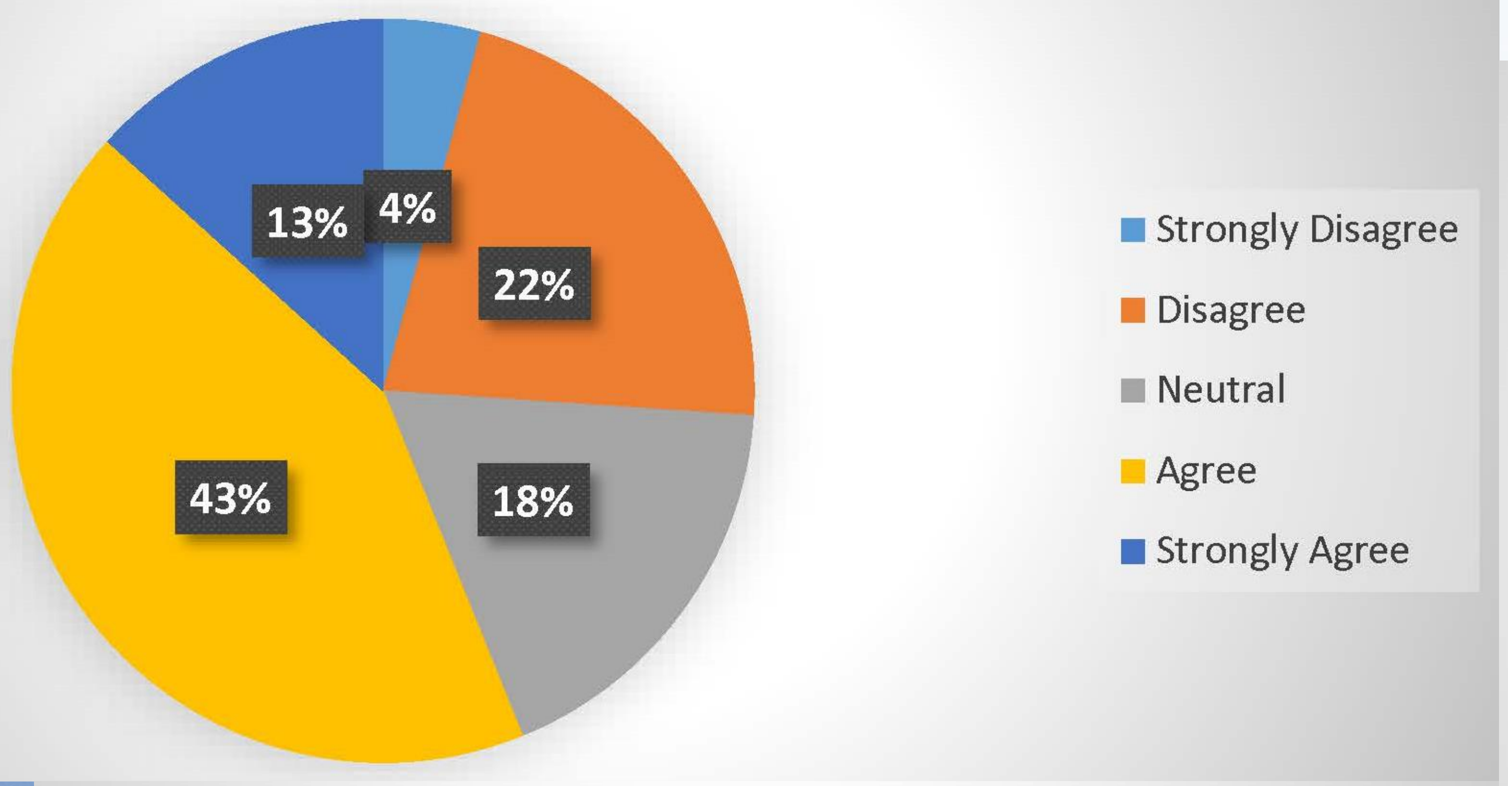
Answer Choices (5):Strongly Disagree to Strongly Agree

CALCS: Active Learning Experiences

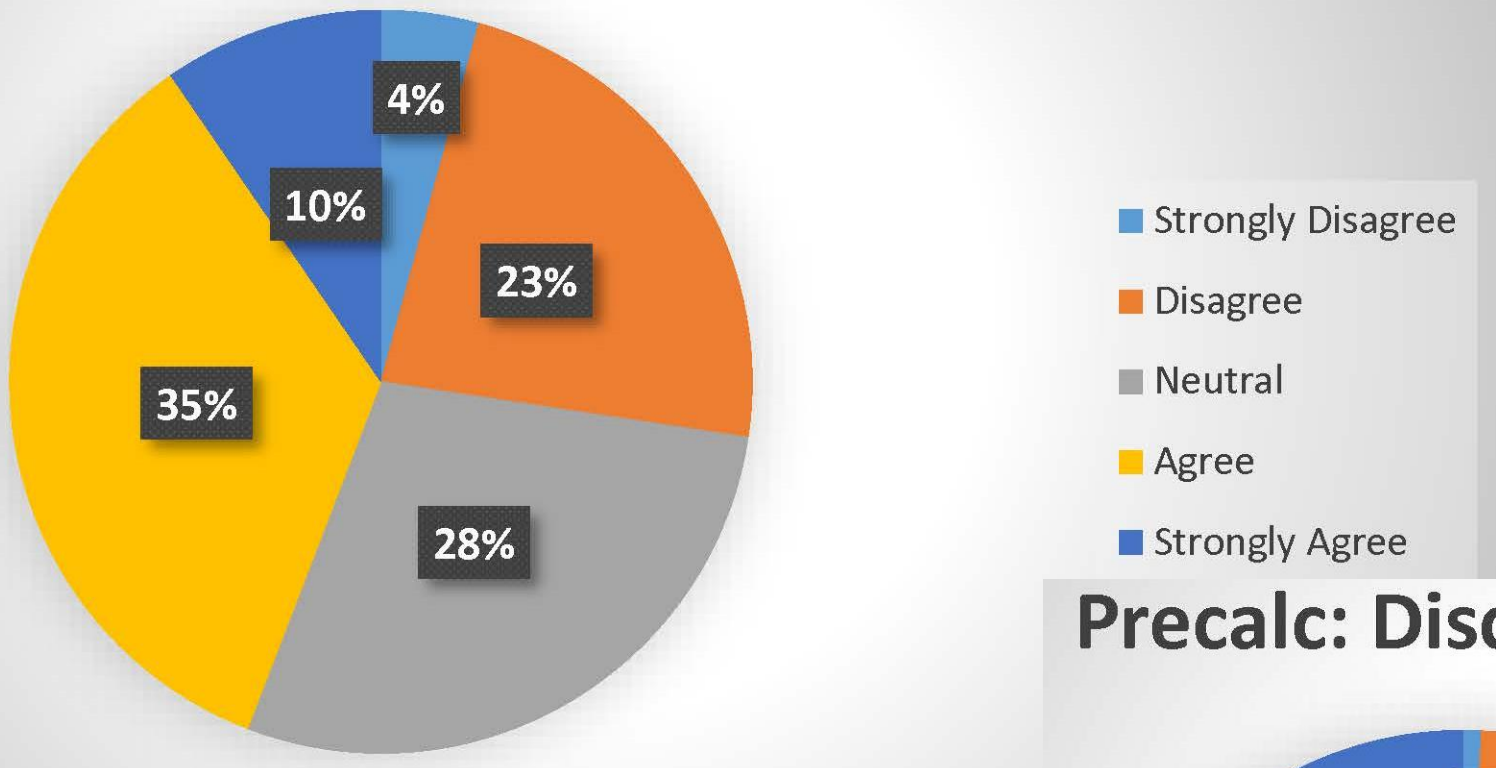
Precalc: Attending/Participating=Helpful



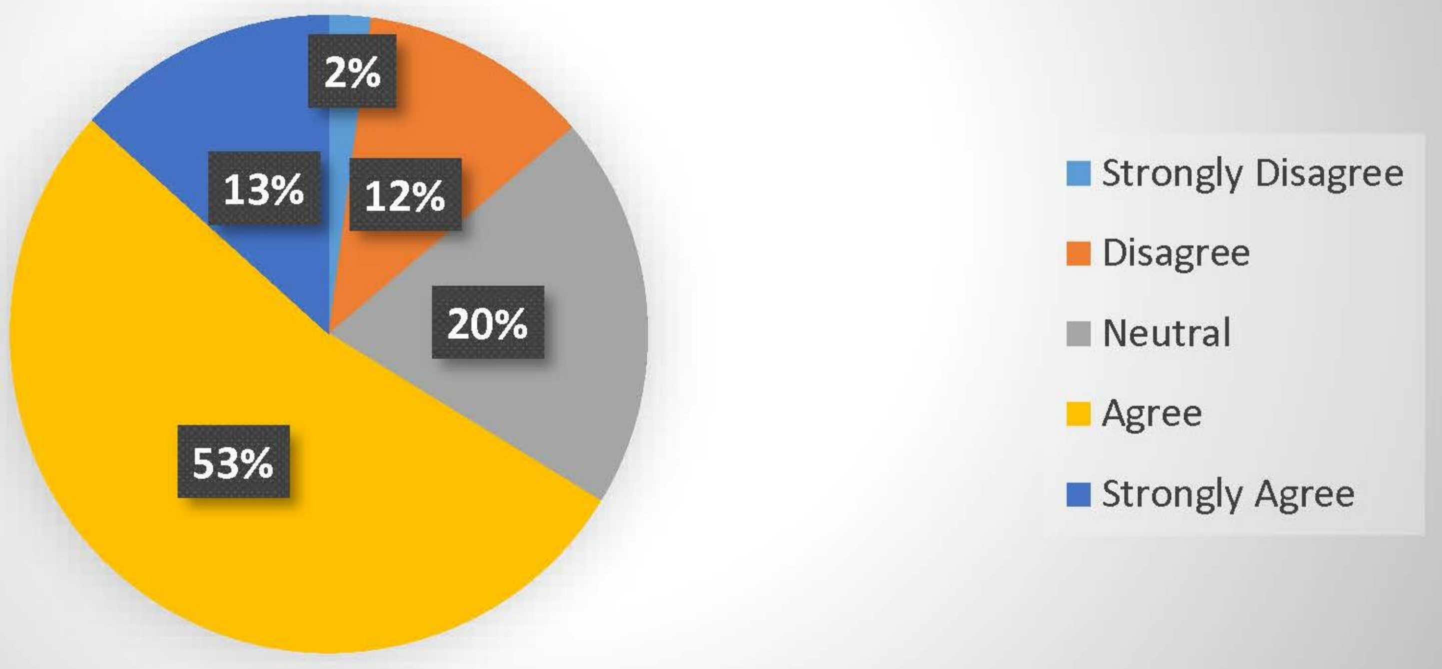
Precalc: Majority of Class=Lecture



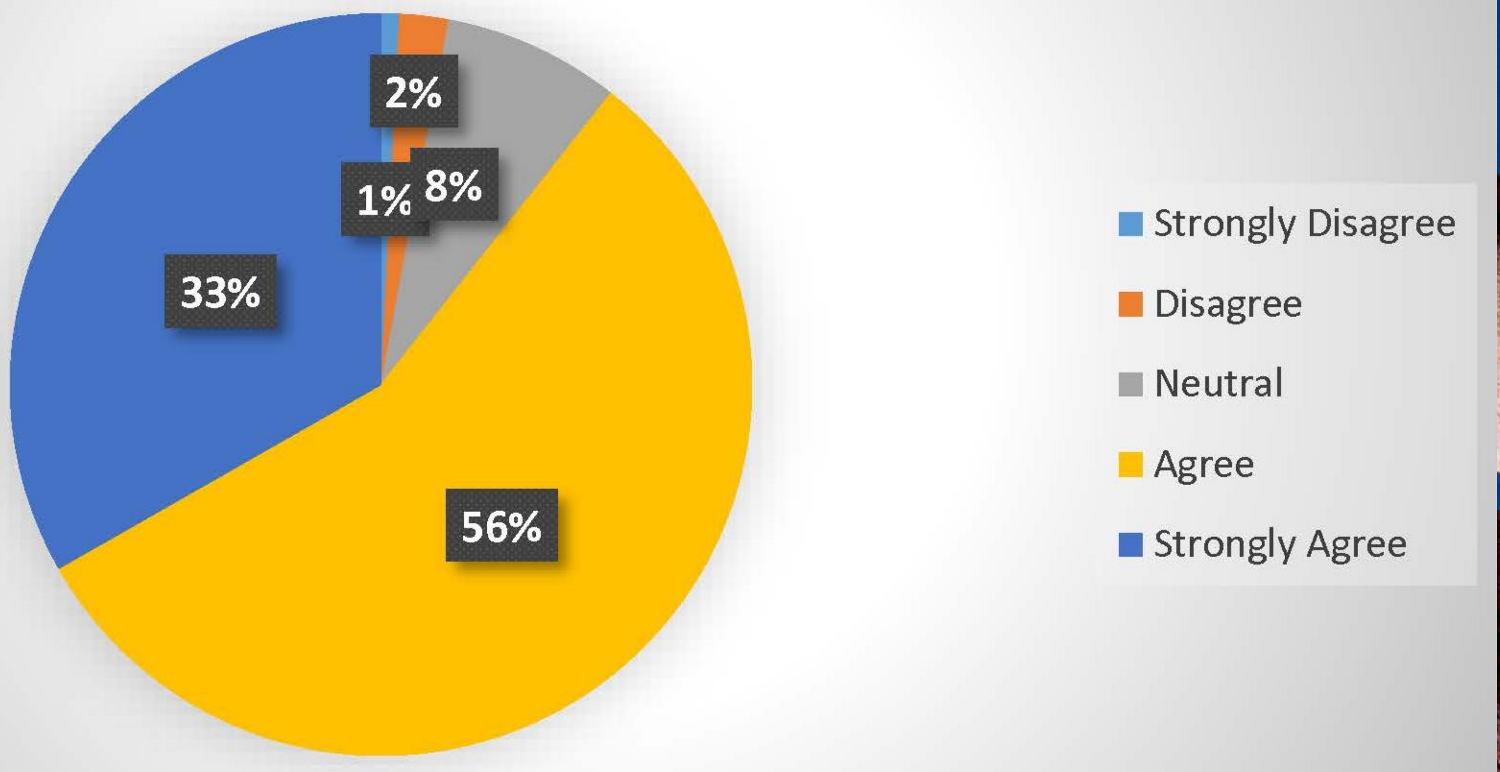
Precalc: Majority of Class=Individual



Precalc: Majority of Class=Cooperative Learning



Precalc: Discussion Opportunities



CALCS: Next Steps

- Revise Active Learning Experiences items prior to Dec 2016 administration
- As SEMINAL ramps up, more students will take CALCS
- Compile & analyze longitudinal data across diverse institutions
- Connect belief data to other data

Questions?

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