Chemistry
University of Utah

Course-level social belonging: Effects on student performance and persistence in General Chemistry

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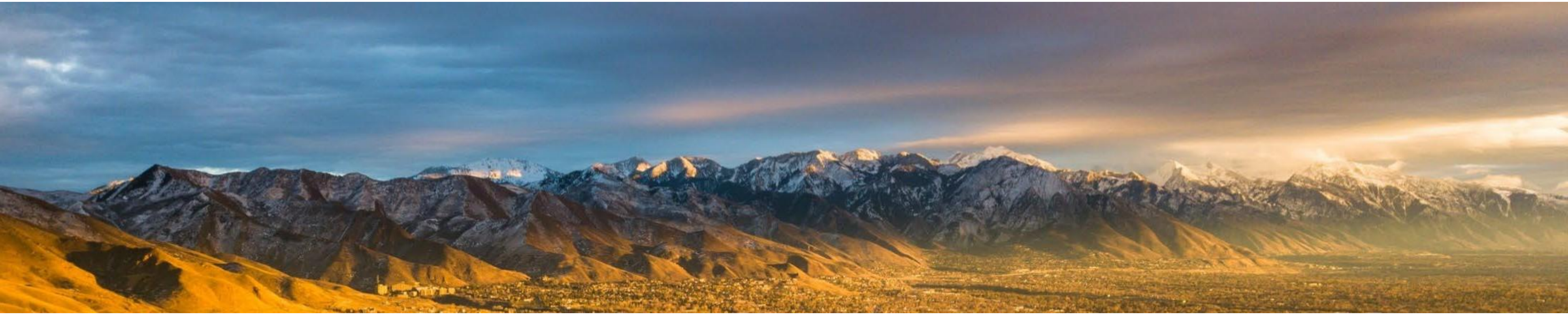
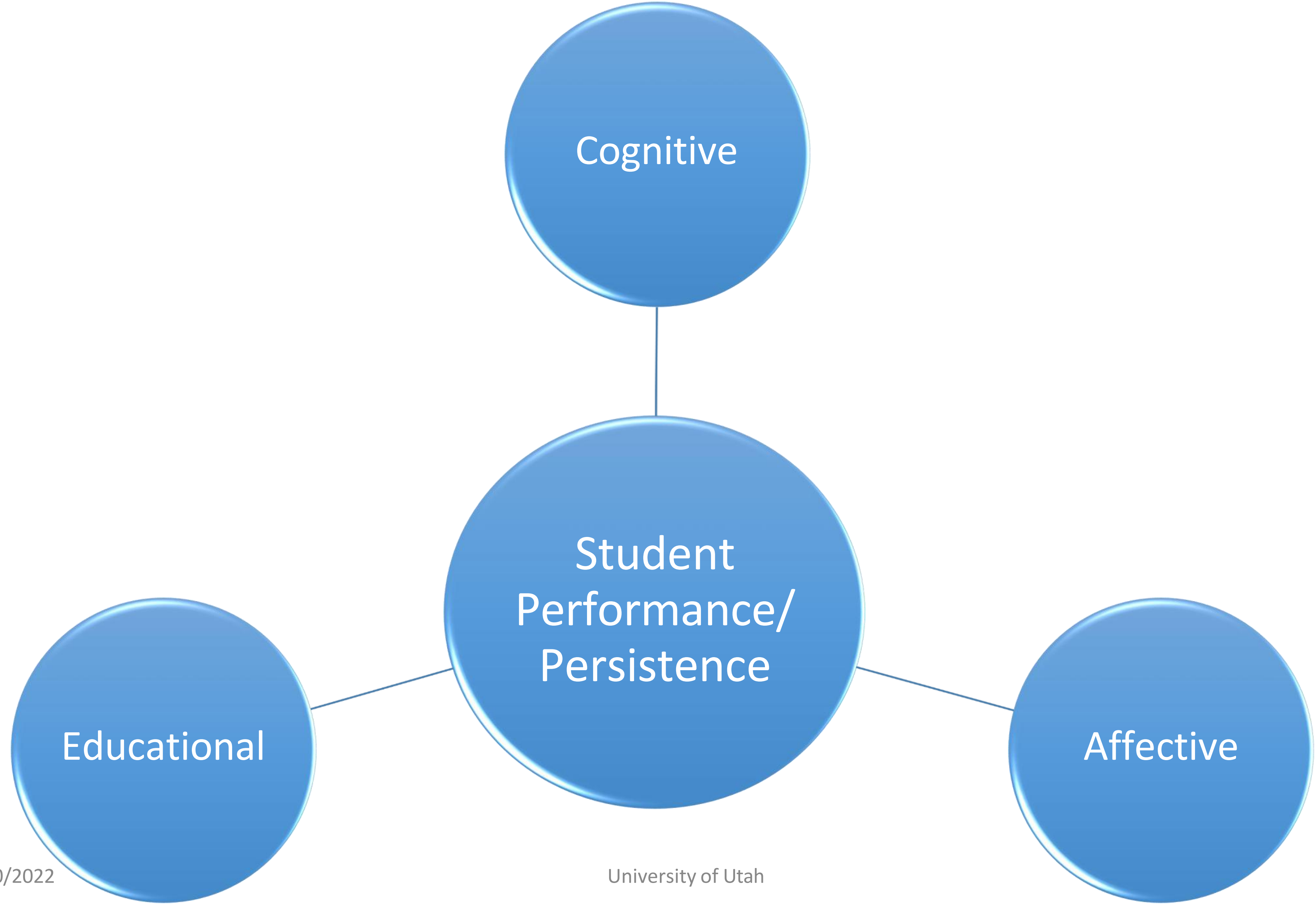



Cognitive
Student Performance/ Persistence
Educational
Affective

Social Identity

- **Social Identity**: self-concept derived from membership in social groups (Tajfel & Turner et al., 1979)
  - Age, ability, ethnicity, first language, gender, national origin, race, religion, sexual orientation, socio-economic status…

- Individuals' multiple identities are salient in different contexts, can intersect/ interact in complex ways

- **Identity threat:** when individuals fear their treatment will be contingent on one of their social identities (Steele, Spencer, Aronson, 2002; Walton, Murphy, Ryan, 2015)

- Students' social identities shape how they
  - Gather information about how they are welcomed and valued by their peers
  - Interpret feedback
  - Are aware of numerical diversity in their environment

Social Belonging

- Belonging or having stable, positive relationships with others is a basic human need (Baumeister & Leary, 1995)
  - Connectedness to a social, spatial, cultural, professional, or other type of group or a community (Hurtado & Carter, 1997).

- "The extent to which individuals feel like a valued, accepted, and legitimate member in their academic domain." (Fink et al., 2020)
  - "Academic domain" can be an institution (i.e., The University of Utah), a field of study (i.e., chemistry), a class (i.e., General Chemistry)

Social belonging is important in academic settings

- Social belonging is an important psychological factor associated with college-student motivation, achievement, and retention (Murphy & Destin, 2016)
- Groups underrepresented in higher education and in STEM often report less belonging (Trujillo & Tanner, 2012) and more uncertainty about their belonging (Walton & Cohen, 2007, 2011)
- Independent effects of different levels of belonging – course, major, and university – on undergraduate STEM students' behavioral and emotional engagement in their courses, with course-level belonging proving most influential (Wilson et al., 2015).
- The impacts of social belonging and other affective factors on outcomes in STEM are being studied across gender and racial/ethnic identities, and the effects on other underrepresented groups (e.g., first-generation students) are less understood.

Two facets of Social Belonging

- Sense of Belonging
  - Perceived belonging reflects students' overall evaluations of their fit and social relationships in educational settings, indicating whether they generally agree or disagree that they belong.

- Belonging Uncertainty (less studied)
  - Term introduced by Walton and Cohen (2007)
  - Awareness of educational inequities and stereotypes, experiences with discrimination, and other threats to inclusion can cause students from underrepresented groups to question or doubt the quality of their social connections in educational settings (Mallett et al., 2011).
  - Probes the relative stability and performance contingency of students' perceived belonging

Adapted course-level belonging measures

Sense of belonging (SB)

- I feel like I fit in General Chemistry.
- I feel comfortable with my peers and classmates in General Chemistry.
- I feel comfortable with my professors in General Chemistry.
- Setting aside my performance in class, I feel like I belong in General Chemistry.

Belonging Uncertainty (BU)

- I feel uncertain about my belonging in General Chemistry (i.e., sometimes I feel that I belong, sometimes I don't)
- When I don't perform well, I feel like maybe I don't belong in General Chemistry.

Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6

Adapted: Both scales, Fink et al (2020); People in General Chemistry are a lot like me.

SB original: (London et al., 2013; Walton & Cohen, 2007, 2011); BU original (Walton & Cohen, 2011)

Why look at belonging in General Chemistry?

- Most students are experiencing a critical period of personal and academic development.
- The transition to college is challenging for most students (Tinto, 1993), but compounded for students from under-resourced or marginalized groups who may feel alienated by the cultural norms of the institution (e.g., Stephens et al., 2012)
- May prove especially acute in large-enrollment, lecture-based, introductory STEM courses like general chemistry, where rigorous coursework is combined with an unfamiliar learning environment and often limited opportunities for individual participation during class.
- Understanding how early belonging varies and impacts first-year students' success in general chemistry may point chemical educators towards new strategies for supporting their students and retaining more talent in STEM and healthcare fields.

Studies at 2 different institutions

- Washington University in St. Louis
  - Private highly selective research-intensive institution

- University of Utah
  - Public land-grant research-intensive institution

- Both large General Chemistry courses with multiple sections taught as a single section (N = 800-900)
  - Multiple instructors
  - Sections have same homework, quizzes, exams, syllabi, and all students are graded commonly with same absolute grading scale

What are the impacts of student social belonging on student outcomes in General Chemistry?

- How does social belonging in General Chemistry differ according to demographics (i.e., gender, race/ethnicity, & first generation) and academic preparation (i.e., math abilities, content knowledge, & college–preparatory experience)?

- How does social belonging affect performance and persistence in General Chemistry series?
  - How do these effects differ according to demographics (i.e., gender, race/ethnicity, & first generation) and academic preparation (i.e., math abilities, content knowledge, & college–preparatory experience)?

- Is there a recursive effect between social belonging and course performance?
  - How do these effects differ according to demographics (i.e., gender, race/ethnicity, & first generation) and academic preparation (i.e., math abilities, content knowledge, & college–preparatory experience)?

Key Findings from the 2 Studies

- In two institutions with different populations, large GC courses,
  - **Generalizability of course-level social belonging survey instrument with 2 factors**
    - Sense of Belonging and Belonging Uncertainty are statistically separate factors

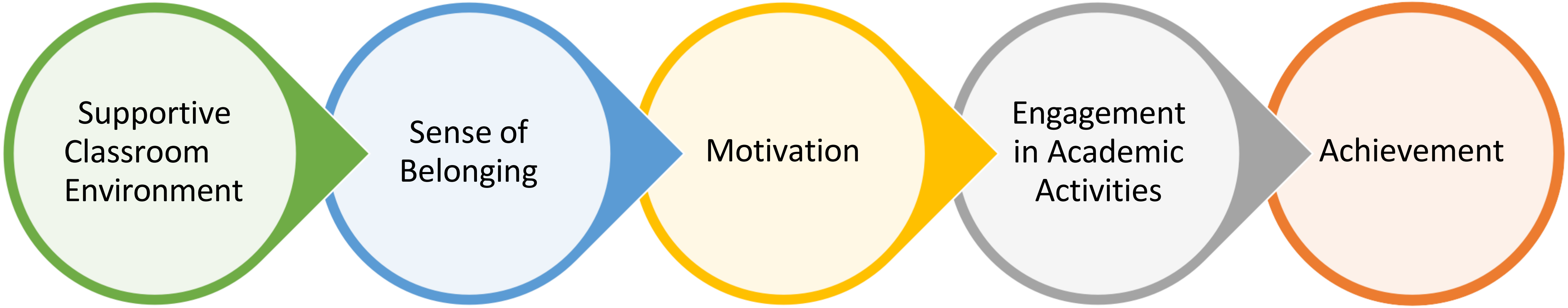
  - What affects early-semester SB and BU:
    - Gender difference in SB and BU: **Men had higher SB and lower BU than women**
    - Inconclusive about academic background affecting early SB/BU
      - At Wash U, AP and pre-content knowledge (not ACT Math) affected SB and BU for all students
      - Not seen at Utah
    - Small size effect (0.03 – 0.07)

Additional Key Findings from Wash U

- Early-semester SB/BU affects performance (cumulative final exam score) in **both GC1 and GC2 for all students**
  - After taking into account academic background (ACT, 1.2 pts; Pre, 0.18 pt), PLTL participation (5 pts)
  - Approximately 1.7 points on exam for 1 point in SB or BU (SB GC1; SB & BU GC2)

- **Persistence in the series**: Late semester SB affects continuing and finishing second semester GC2
  - After adjusting for academic preparation, demographics, PLTL participation, & GC1 performance
  - As late-semester GC1 SB increased from 4 (mildly A) to 5 (A) to 6 (SA), her predicted probability of attrition decreased from 20.2% to 6.2% to 0.6%, respectively (an average-preparation Asian, female, PLTL non-completer)

Why might belonging affect performance (one current model; not yet shown in science, math, and engineering)?



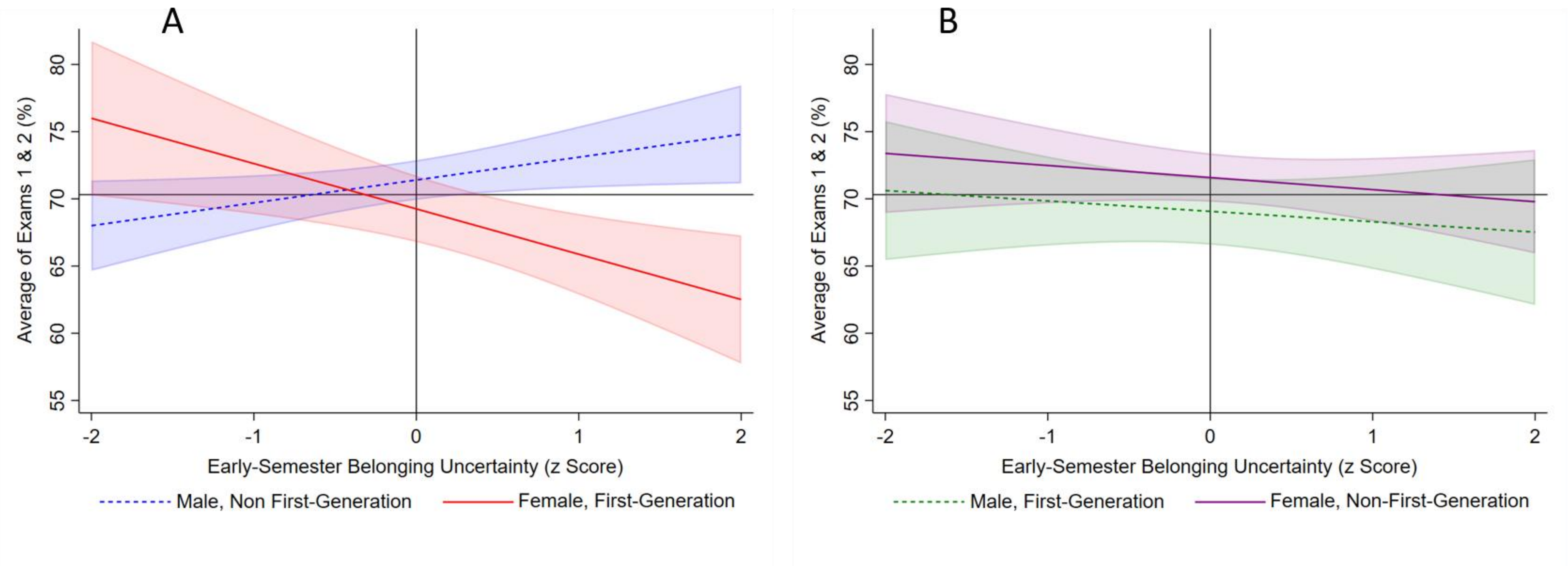
- **Recursive Process:** affect-cognition-behavior chain is thought to be cyclic and self-reinforcing, such that negative self-perceptions contribute to maladaptive learning strategies and poor performance, which beget more negative perceptions, and so on (Yeager & Walton, 2011).

Zumbrunn, McKim, Buhs, Hawley, 2014

Recursive Process Study - Utah Study

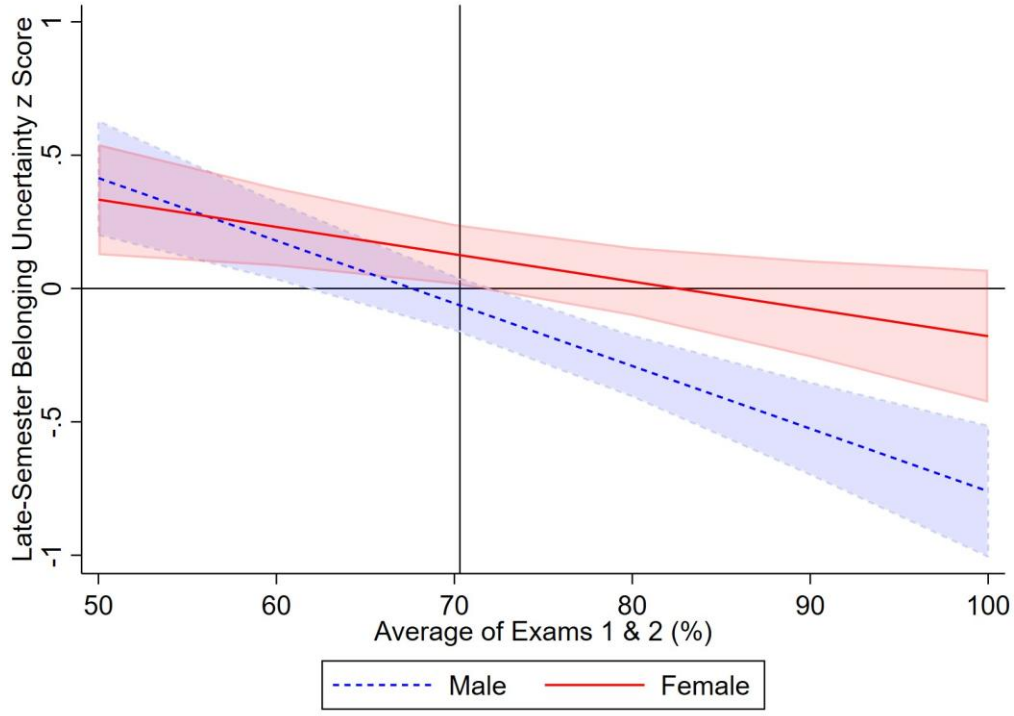
- Recursive process seen in GC1

- **Step 1: After Accounting for Academic Preparation (ACT Math and Pre-assessment Test), Early-Semester Belonging Uncertainty Negatively Affected Midterm-Exam Performance (Average of Exams 1 and 2) Only for the Intersectional Group of First-Generation Students and Women**
    - ACT math (1.3 pts); Pre-knowledge (0.9 pts) for all students



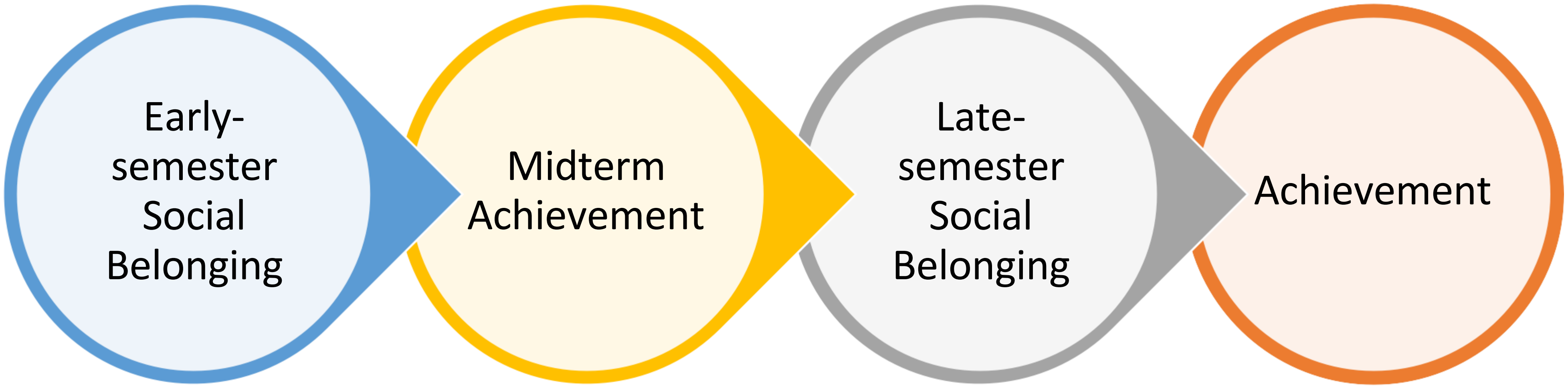
Recursive Process Study - Utah Study

- **Step 2: Mid-term performance predicted late-semester social belonging (both factors) for all students.**
  - Pre-knowledge and ACT Math did not predict SB or BU
  - Example of mid-term performance on SB and BU
    - A student having an 80% average would be expected to report a BU score that is 0.17 standard deviation above the BU score of a student with a 90% exam score
- Women again experience higher BU score than men, even with comparable exam performance



Recursive Process Study - Utah Study

- **Step 3: Late-semester sense of belonging predicted noncumulative final exam performance.**
  - Again pre-knowledge and ACT Math predicted exam score similar to the early exam score effect (*ACT math (1.4 pts); Pre-knowledge (0.9 pts) for all students)*
  - Late semester SB (but not BU) predicted exam score for all students;
    4pts higher on exam for 1 standard deviation increase in SB score



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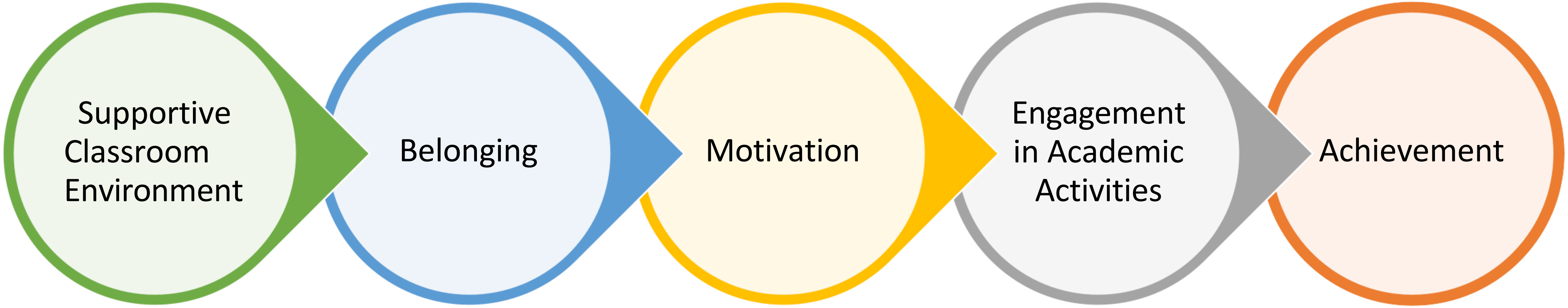


- **Recursive Process:** affect-cognition-behavior chain is thought to be cyclic and self-reinforcing, such that negative self-perceptions contribute to maladaptive learning strategies and poor performance, which beget more negative perceptions, and so on (Yeager & Walton, 2011).

Zumbrunn, McKim, Buhs, Hawley, 2014

Implications for instructors

- Create a inclusive and supportive environment
  - Check material and language
    - Include examples of different genders, races/ethnicities, first generation, etc.)
  - Encourage growth mindset for both instructors and students
    - A belief that all learners' can grow and improve. Set your assessments to encourage this process. Reinforce at critical points in the semester (e.g., after each exam has been taken) when students struggle to maintain positive self-beliefs.
    - Use multiple types of assessments and lower percentage of grade that is based on number of high-stakes assessments
- Target motivation: e.g., Use utility-value interventions
- Target Engagement: e.g., Use active-learning, collaborative strategies
- Use multiple interventions and reinforce throughout the semester and into the second semester of the course

Group members and Collaborators

Current Group Members

- Graduate Students
  - Josh Edwards
  - Lori Laguerre
  - Hector Torres

- Undergraduate Researchers
  - Hannah Blomgren
  - Dasha Walker
  - Eva Quintus-Bosz
  - Salma Djalal
  - Maria Munoz
  - Sophie Humpherys
  - Mark Jareczak (REU; Wash U)

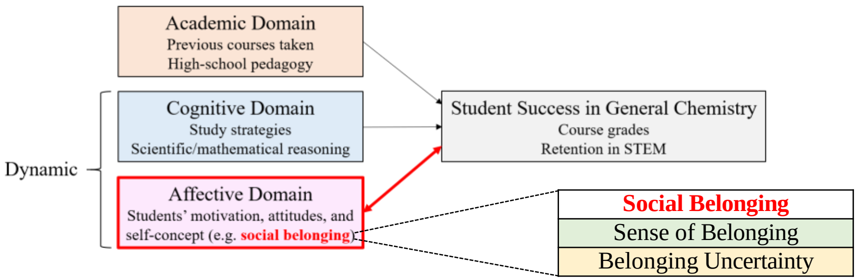
Group Website: https://chem.utah.edu/directory/frey/research-group/

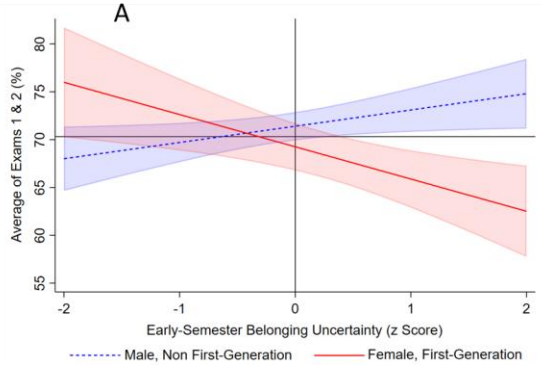
Collaborators

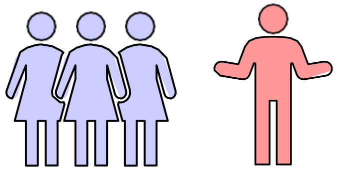
- **Ramón Barthelemy, The Department of Physics, Utah**
  - **Effect of Classroom Inclusivity on student outcomes in STEM**
- Center for Science and Mathematics Education (CSME; Utah)
  - Learning Assistant (LA) project
  - HHMI UPSTEM project
- **Center for Integrative Research on Cognition, Learning, and Education (CIRCLE; Washington University in St. Louis)**
  - Peer Led Team Learning (PLTL) project
  - **Classroom Inclusivity and social belonging project (HHMI)**
  - Concept-building Approach project
  - Social Network Analysis (HHMI)
- Inclusive STEM Teaching Project (Multi-institutional NSF Grant)
  - Faculty/Future Faculty online Inclusive Teaching program

Frey Group Research

Social Belonging and Inclusive Learning Environments





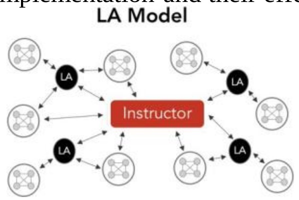


Projects:

- Belonging in UofU general chemistry, organic chemistry, introductory physics
- Belonging in SLCC introductory biology

Peer-Assisted Collaborative Learning

Peer Leaders include roles of LA, SI, PLTL, and undergraduate TA. We are looking at Learning Assistants (LAs) who facilitate discussions among groups of students in classroom settings to encourage active engagement. Our group studies LA implementation and their effect on classroom inclusivity.



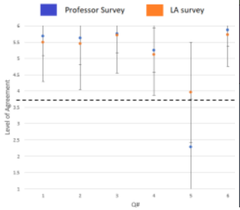
Projects:

- UofU faculty LA implementation in STEM
- UofU LA course inclusivity in STEM

Study methods used

- Survey
- Interviews

Categories	Q #	Survey prompt
LAs support students	1	Actively encourage students to work together
	2	Encourage student participation in class
	3	Support students in productive struggle
LAs support instructors	4	Communicate students' feedback to the instructor during class
LA actions in the classroom	5	Teach discussions/ classes
	6	Move through the class guiding ongoing student work during active learning tasks



LAs effect on students (61% of responses)	LAs act as a peer mentor	LAs encouraged students by acting as a peer and providing help with course material.
	LAs support students in productive struggle	The quote includes the words "productive struggle"
LAs effect on professor (9% of responses)	Teaching team learns from LA	LAs provide information that they learned in their pedagogy course to enhance teaching methods for the teaching team(professors, TAs, LAs, and SI leaders)
LA model affects on course (31% of responses)	LAs help instructor implements active learning	Having LAs in the course provides the needed resources needed to involve active learning in the class setting
	LAs help instructor to incorporate group work	The use of LAs provided additional resources needed to facilitate group work in the classroom setting

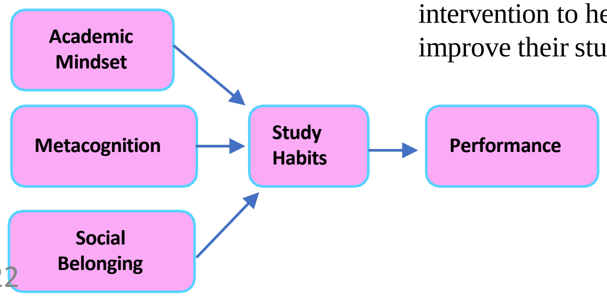
Cognition and Metacognition

Research Questions:

1. What types of self-directed study behaviors do STEM students have and what is the effect on their performance?
2. What effect does academic mindset have on self- directed study behaviors of STEM chemistry students?
3. What effect does social belonging have on self-directed study behaviors of STEM students?

Purpose

Develop a metacognitive intervention to help students improve their study habits.



Projects:

- Study Habits in UofU general chemistry, organic chemistry
- Study Habits in SLCC introductory biology

Faculty development

With an ever-changing student demographic, instructors often look for new strategies in which they may help to build an equitable learning environment so that all students may succeed in their course.

Projects:

- Multi-institution on-line faculty development course with local learning communities (ISTP)
- UofU and SLCC faculty-learning community

INCLUSIVE STEM TEACHING PROJECT

Research tools and skills we use:

- Survey instruments
- Observational instruments
- Cognitive and social psychology
- Quantitative and qualitative analysis

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Thank you for listening.

Questions/Comments?