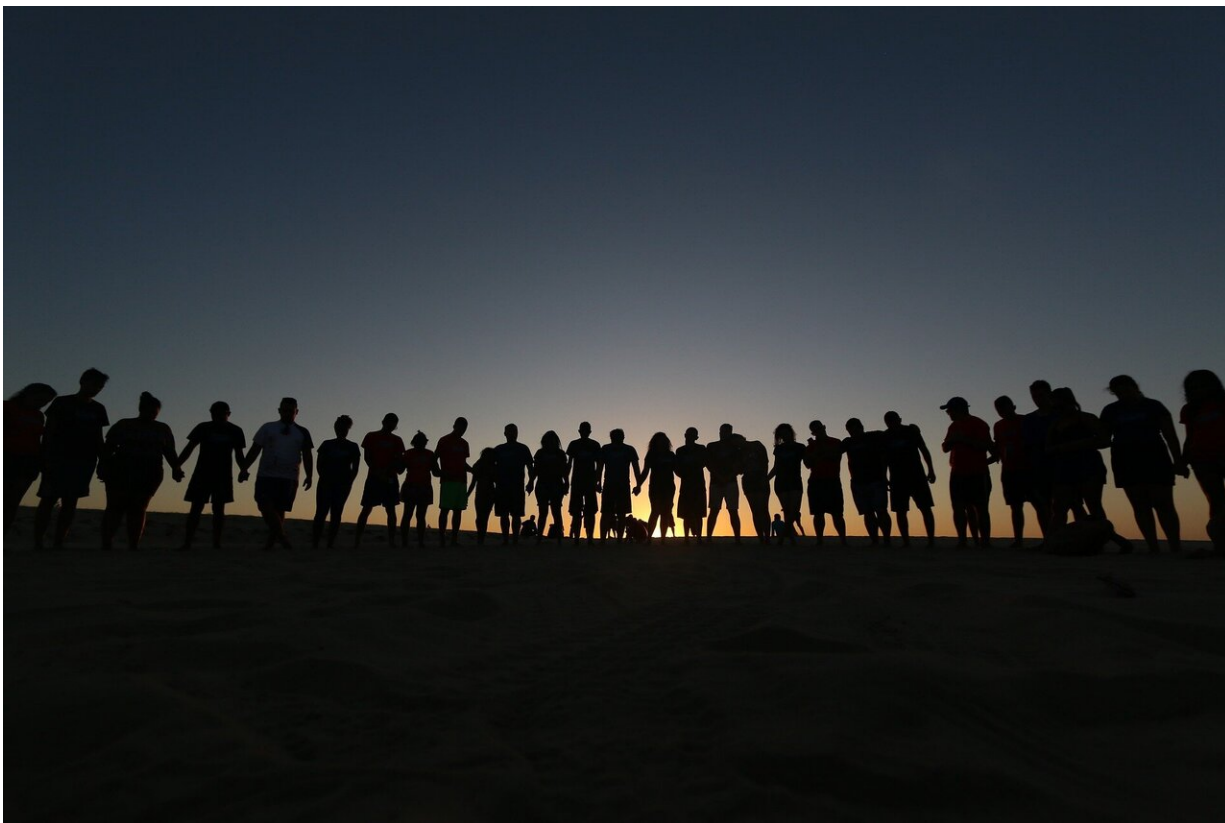# Belonging insecurity in STEM courses can affect grades

September 20 2021, by Paul Gabrielsen

Credit: CC0 Public Domain

As a first-year college student in an introductory chemistry class sits down for their midterm, which might be their first stepping stone toward a career in academia, research or medicine, a thought may swirl through

their head alongside valence numbers, molar masses and oxidation states—an anxiety that forms itself into a supposition: "Maybe people like me don't belong in this class."

That thought is called belonging uncertainty, a feeling of social insecurity related to a person's identity. New research from the University of Utah shows that belonging insecurity in a STEM course, specifically a first-year chemistry course, can affect a student's midterm scores, which can then feed back into the student's belonging uncertainty. For students in groups that are underrepresented in STEM, there's a danger that such a feedback loop could cause them to decide that science isn't for them, deterring potential scientists from even entering a STEM field.

"Students in these early STEM courses face many struggles and challenges, such as learning to adjust their study strategies, that are normal for this academic transitional period from high school to college," says chemistry professor Gina Frey. "The concern is that a student with a high belonging uncertainty has a less stable sense of belonging and will believe the struggles they encounter in these courses are due to their identities as opposed to a normal part of the academic transition that everyone faces in their early years at college."

The research is published in the *Journal of Chemical Education* in a special issue on diversity, equity, inclusion and respect in chemistry education research and practice.

Sense of belonging and belonging uncertainty

Belonging uncertainty is different than simply a sense of belonging. A sense of belonging is an individual feeling, Frey says, (i.e. "Do I belong here?") while belonging uncertainty is tied to the groups in which a person identifies.

"The more uncertain a person is in their belonging," Frey says, "the more aware they are of the problems specific identity groups may have in belonging to a community, and therefore the person may form a feeling that 'people like me (i.e., a certain identity group) do not belong here.'"

In a study last year at another university, Frey and her colleagues saw how the difference between the sense of belonging and belonging uncertainty played out. The researchers followed students through General Chemistry 1 and 2, and found that women entered each class with a lower sense of belonging and a higher belonging uncertainty than men, even with the same academic preparation (as measured by ACT math scores and pre-assessment test scores). By the late semester, women still expressed higher belonging uncertainty than men, although their sense of belonging had increased. Both belonging measures, the researchers found, were correlated with exam performance.

But between belonging measures and exam scores, what is the cause and what is the effect? Other researchers had previously hypothesized that belonging and academic performance were tied together in a feedback loop—higher belonging uncertainty may lead to lower exam scores, which in turn reinforces belonging uncertainty and so on.

In the new study Frey, chemistry graduate student Joshua Edwards and physics and astronomy assistant professor Ramón Barthelemy set out to explore the recursive phenomenon within the bounds of a single course: General Chemistry 1.

Recursive effects

In all, 725 students participated in the study, which was conducted during the Fall 2020 Semester amid hybrid learning options due to COVID-19 (more later on how that impacted the study). With consent, the researchers compiled student demographic data, academic

preparation information, and scores on the course's three exams (two midterms and a final). They also assessed belonging with a short questionnaire given at the beginning and end of the semester.

The results showed that belonging uncertainty and test performance interacted with each other as hypothesized. In general, students' mid-term performance predicted their late-semester belonging uncertainty. And that uncertainty predicted their score on the final exam.

Frey says she and her colleagues were surprised to see that the benefits of a good midterm score on belonging uncertainty applied to men and women differently. When men received high test scores (90% or above) their belonging uncertainty fell (suggesting more security in their belonging) significantly. But for women, even with the same good scores, belonging uncertainty didn't go below the class average.

"This means that, at least for women, there is a limit to how much performance gains can improve social belonging," Frey says. "The consistently higher belonging uncertainty we see for women in STEM courses could affect the retention and persistence of women in STEM fields, and improving performance is not the only factor necessary to mitigate this gender-based belonging gap in STEM."

The researchers also found that intersectionality, or belonging to more than one underrepresented group, deepened the belonging-academic cycle. For the group of students who were both women and first-generation students, each standard deviation increase in belonging uncertainty (a statistical term signifying a distance from the class average) carried with it as much as a 6% decrease in the average midterm grade.

How to break the cycle

Both instructors and students can help to break the cycle of belonging uncertainty, Frey says.

Instructors can help by implementing collaborative activities to encourage peer interaction. "It is critical that students see that their learning experience and all the challenges that come with it are shared by most of their peers," Frey says. They can also create a growth mindset and supportive environment, helping students understand that their abilities can grow with time and practice and that mistakes are a part of the learning process. "This is particularly important just after major assessments, such as exams, when students are most likely to make judgments about their own academic abilities," Frey adds.

Instructors can also help by using examples, analogies and diagrams that are non-stereotypical and include different identities. For example, avoiding analogies and references to male-majority popular media and activities, Frey says, can have a substantial impact on students' belonging.

"Instructors should use these teaching practices for all students," she says, "but also focus on underrepresented groups in STEM such as women, first-generation students, and persons of color."

Students can do their part by supporting each other, especially in collaborative activities.

"In qualitative studies that we are conducting, we find that students really value positive and supportive student-to-student interaction during class," Frey says. "Get to know your colleagues or peers in your class, engage in discussion with them, share your perspective and respect your colleagues' perspectives. You may be surprised to find that many students' experiences in the course are similar to your own and that you can help each other learn."

Next steps

The researchers conducted the study during the COVID-19 pandemic and mixed learning modalities. With such a value placed on peer-to-peer interaction, how did the interruption of traditional in-person learning affect the study?

"That is a good question that we think about a lot," Frey says. Because of the unique circumstances of the pandemic, the researchers looked to their previous study for comparison. "We can say with confidence that the result of sense-of-belonging and belonging-uncertainty differences in men and women in STEM courses is robust and generalized," Frey says. Additionally, the researchers are conducting a similar study this fall in an in-person chemistry class, providing another data point for comparison.

"One key difference we are seeing is that in the online/hybrid teaching environment," she says, "students mention the importance of peer-to-peer interaction more often."

The team is also looking at an introductory physics class at the U to see if the same patterns hold in other STEM courses.

Because introductory STEM classes are the foundation for many majors and careers, helping diverse students feel that they belong strengthens diversity in the courses and careers that follow.

"You are not alone in the struggles and challenges you face as a student in your early STEM courses," Frey says. "Everyone can improve with correct study skills and support. Do not be afraid to ask for help. Seeking help from your instructor, peers or other academic resources is what you should do as you are learning."

More information: Joshua D. Edwards et al, Relationship between

Course-Level Social Belonging (Sense of Belonging and Belonging Uncertainty) and Academic Performance in General Chemistry 1, *Journal of Chemical Education* (2021).

Provided by University of Utah