

# **Title: Understanding student Sense of Belonging in introductory STEM courses**

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## **Introduction**

Some STEM fields are characterized by different levels of attrition, based on student gender and generation in college. Evidence suggests that these patterns can be attributed in part to student *affect*, including a student's Sense of Belonging. Doubts about belonging in the classroom are often shouldered disproportionately by students from marginalized groups, which can lead to underperformance and may explain the loss of, for example, women or first-generation college students from science fields (Cohen and Garcia 2008). However, to our knowledge, there is little empirical evidence linking Sense of Belonging to outcomes such as performance or retention in *Norwegian* STEM higher education. We focus here on results of a survey-based study of students in four introductory-level science courses at the University of Bergen in Spring 2022. Our aims were to document Sense of Belonging in this population, and to identify whether Sense of Belonging correlated with student performance, gender or generation in college (whether one or both parents attended higher education). Because an individual's Sense of Belonging can involve how they respond to setbacks or challenges (such as a bad grade on an exam), we also asked students about challenges they had faced in the course, and how they had managed these challenges.

## **Methods**

**Survey instrument:** We surveyed students in four introductory-level science courses (n=249) at the University of Bergen during the last two weeks of the Spring 2022 semester. As part of a larger survey, students were asked to rate their level of agreement with several Sense of Belonging items, such as "How comfortable do you feel in this course?" and "To what extent do you feel accepted in this course?" Response options ranged from 0 (not at all/*ikke i det hele tatt*) to 6 (extremely/*ekstremt*). We asked participants about course challenges via an open-ended prompt: *What specific challenges have you faced as a student -- either in this course, in your study program, or at the university in general? What did you do to overcome these challenges? Try to be as specific as you can.*

In addition to our survey, we also collected end-of-term grades from those students who consented to allow us to access their course grades. Of the 236 students who consented to participate in the study, 101 students consented to share their course grades.

Our study was approved by The Norwegian Centre for Research Data (reference number 963610). We informed students about the general aims of the study, and that the data would be treated confidentially and anonymized in any reporting. Participants could withdraw from the study at any time, and only those who consented to participate were included in the analyses reported here.

**Analysis:** We conducted a series of linear mixed models to analyze the relationships between Sense of Belonging, gender, college generation, and course grades (as letter grades, with passing options ranging from A to E). For the open-ended responses, we used deductive coding to match the student

responses to categories (Table 1) that we assigned after an initial review of a subset of the data. Student responses could be coded into multiple categories.

**Table 1.** The most common categories identified in open-ended responses about challenges

<b>Most Common Categories</b>	<b>Example Statements</b>
Challenges related to the course	<ul style="list-style-type: none"> <li>• That more of the courses (particularly the intro courses) are too big. For instance, I think that KJEM110, BIO100, and INF100 should cover 15 study points each, instead of 10 sp.</li> <li>• Difficult curriculum, and many courses at a time. Stressful periods.</li> </ul>
Coping strategies	<ul style="list-style-type: none"> <li>• If I'm stuck, I ask friends at the same study program, who are also taking the course, for help.</li> <li>• Read a lot to be well prepared.</li> </ul>
Lack of motivation / Trouble focusing	<ul style="list-style-type: none"> <li>• Have struggled a little with motivation, which naturally has affected this course a little bit as well.</li> <li>• Hard to sit down and actually focus on the subject.</li> </ul>
Time management	<ul style="list-style-type: none"> <li>• I work with school instead of relaxing, being social and active, during my spare time.</li> <li>• Often discovered that an assignment needed to be done the day before it was due.</li> </ul>
Overwhelmed, stressed	<ul style="list-style-type: none"> <li>• Many of the courses feel overwhelming with many details and a large curriculum.</li> <li>• Difficult curriculum, and many courses at a time. Stressful periods.</li> </ul>
Feelings of isolation / loneliness	<ul style="list-style-type: none"> <li>• I have been sick a lot after I had corona in the middle of this semester. This has also made the studying more difficult.</li> <li>• Diseases that are connected with stress, interfere with my whole life, particularly at school.</li> </ul>

## Results

We found that male students have a higher sense of belonging than their female counterparts ( $p = 0.0155$ ). We also found that students with a higher sense of belonging perform better in their courses ( $p = 0.003$ ). We did not detect a relationship between Sense of Belonging and generation in college ( $p=0.8$ ).

Combining student scaled responses with open-ended questions about challenges they faced in the course can shed some light on the underpinnings of these differences. For example, one woman with a low Sense of Belonging wrote “I feel that everyone I talk to is sailing through just fine and it’s just me who is struggling.” And another said, “I felt stupid...I was afraid to ask questions.” Conversely, a man with a high Sense of Belonging shared “I have actually managed quite well.”

## Discussion

Our ability to extrapolate from this work is limited by a small sample size, and a restricted survey distribution in just four courses in one mathematics and natural sciences faculty, at one university.

However, our main findings—that Sense of Belonging varies by gender—echo similar work in other contexts (e.g., Walton & Cohen 2007, Rainey et al. 2018, Gopalan & Brady 2020) and may point to some explanatory factors behind the differential attrition between women and men in STEM fields in Norway. If, for whatever reason (e.g., stereotype threat; Steele 1997), women are more likely to see challenges in a course as indication that they do not belong in that course or discipline, then they may be more likely to opt out of pursuing further study in that area.

Fortunately, we can learn from social-belonging interventions that have, in many studies (Walton et al. 2015, Yeager et al. 2016, Murphy et al. 2020) successfully countered these psychological threats. And recently, investigators (Binning 2020, Hammarlund 2022) have demonstrated gains with a version of these interventions—an ecological-belonging intervention that is explicitly designed for implementing in the natural context (or *ecology*) of the classroom. Specifically, Binning et al (2020) led students through an exercise in which the students were encouraged to see course challenges as *normal*, *temporary*, and *surmountable*—and not, for example, as an indication that everyone is doing just fine and they are the only ones struggling.

Future work will attempt to contextualize the impacts of this intervention in a Norwegian context, and hopefully give us some indication of possible strategies for countering the problem of attrition in STEM higher education.

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