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## Introduction

A student's sense of belonging is essential to retention in STEM, with evidence of improvement in academic performance. Given the COVID-19 pandemic and the necessity of online learning, we were curious about the impact of virtual classrooms on belonging and other course dynamics. In this study, we focused on identifying what classroom characteristics contribute to an increased sense of belonging in classes before and during COVID-19.

## Methodology

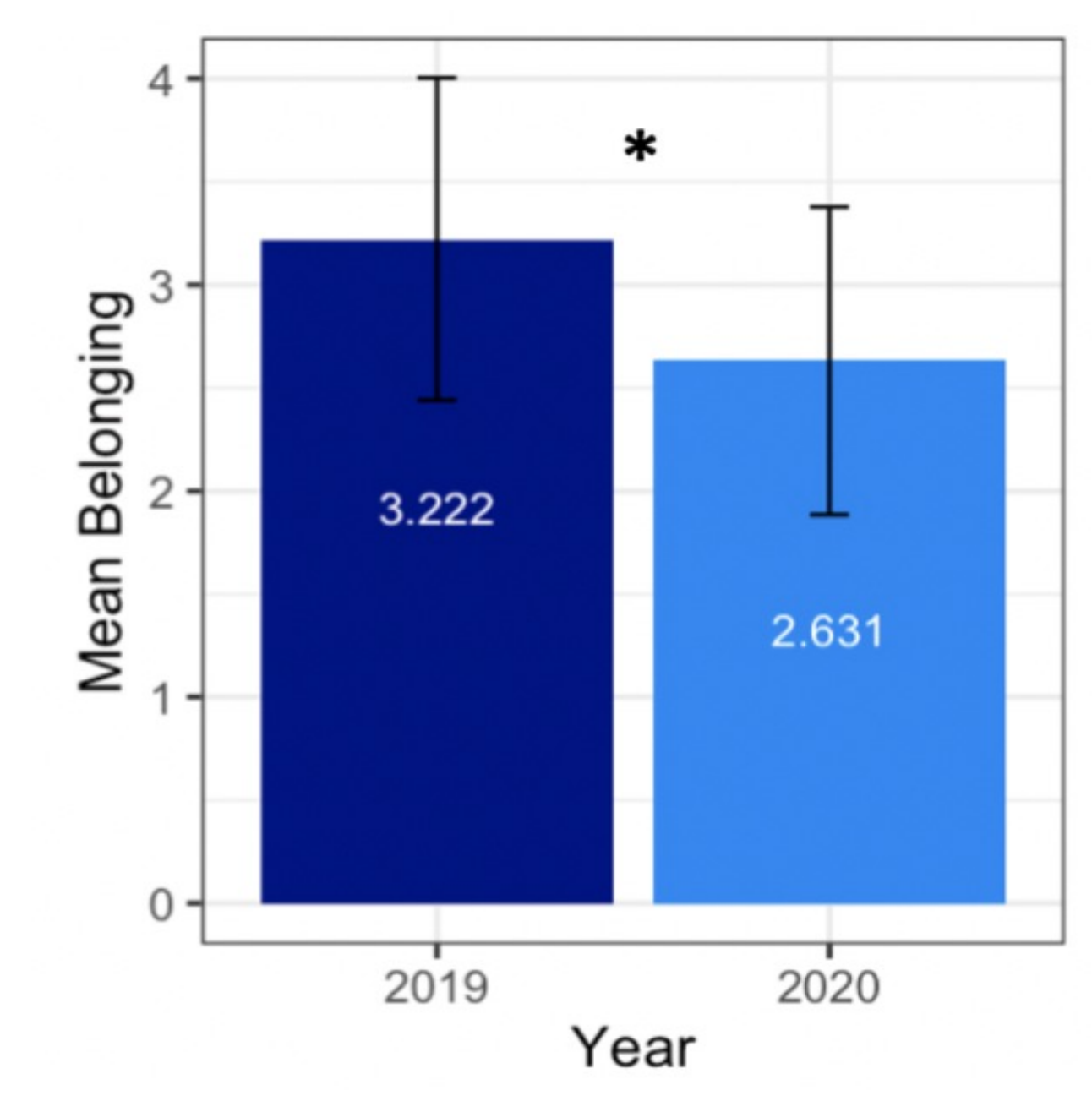
**Sample size:** In 2019, 51 courses with 889 student responses; In 2020, 13 courses with 379 student responses.

**Measures:** (1) sense of belonging; (2) perceptions of competition; (3) course structure, (4) importance of attending class; and (5) the effect on learning.

**Analyses:** ANOVA with Tukey post-hoc tests. For a more direct comparison, only the 13 courses offered in both 2019 and 2020 were included in this analysis.

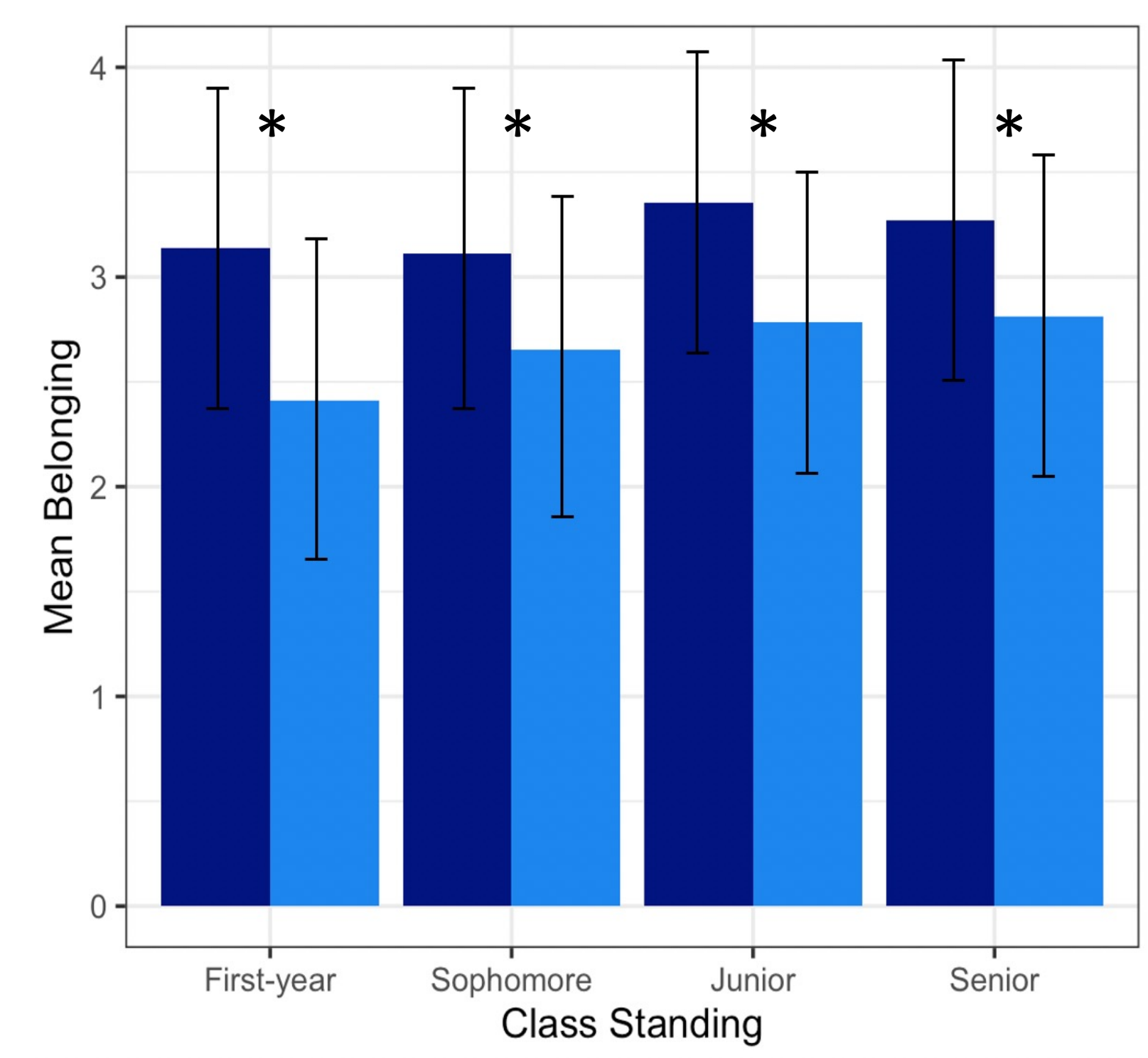
**References**  
 A customized belonging intervention improves retention of socially disadvantaged students at a broad-access university (Murphy et al., July 2020)  
 Student Stress, Mental Health, and Well-Being During COVID-19 (Duke Office of Undergraduate Education, January 2021)

## Figures

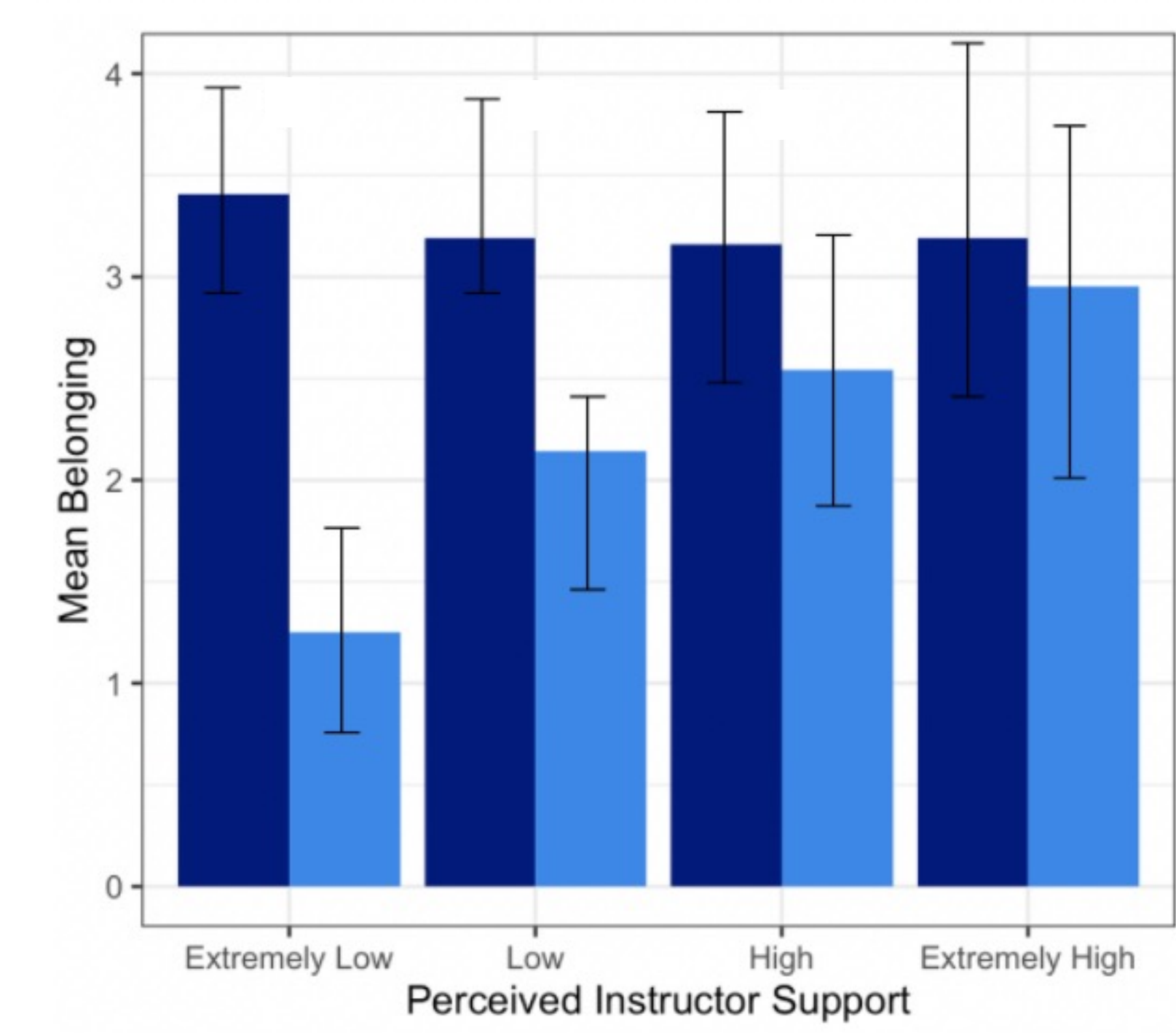


2019 2020

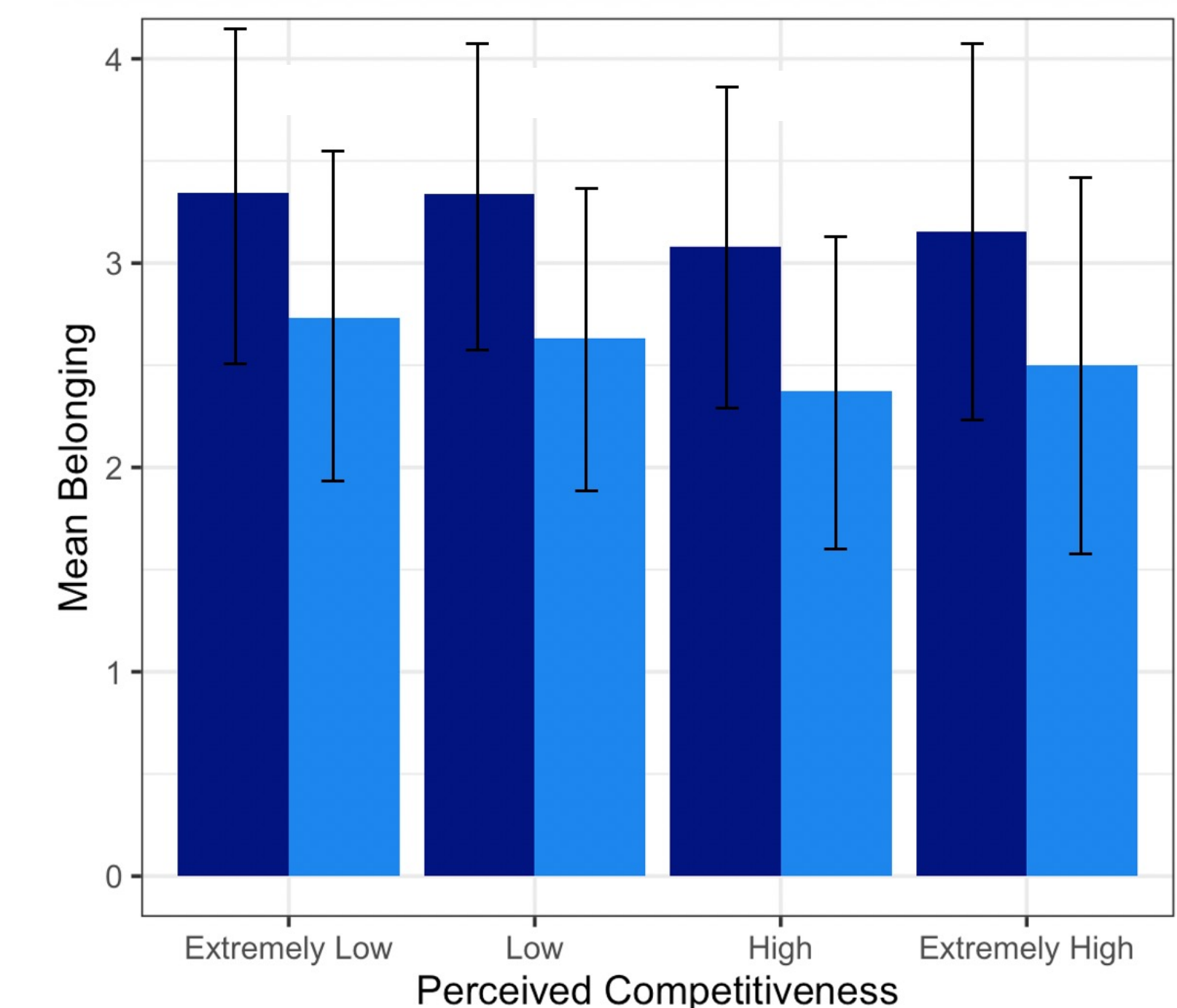
**Figure 1:** A significant drop in sense of belonging in STEM courses in 2020 compared to 2019.



**Figure 2:** The drop in 2020 from 2019 in sense of belonging in STEM courses is significant within every class standing.



**Figure 3:** Sense of belonging across varying levels of perceived instructor support was significantly different in 2020 ( $p < .05$ ), but not in 2019.



**Figure 4:** Sense of belonging across varying levels of perceived competitiveness was significantly different in 2020 ( $p < .10$ ), but not in 2019.

## Results

- Between 2019 and 2020, sense of belonging significantly decreased overall.
- In 2020, first-year students had the lowest sense of belonging.
- Perceived level of instructor support had significant effects on belonging in 2020 but not in 2019.
- The relationship between competitiveness and belonging was significant only in 2019 but not in 2020.
- In both 2019 & 2020, belonging was significantly correlated with: (1) stress related to course content; (2) importance of attending class; (3) motivation to attend class; and (4) preparation for class.

## Discussion

As colleges prepare for the eventual return to in-person learning, we expect that students' sense of belonging will return to in-person, pre-COVID levels. As long as online classes continue, instructors should place a special emphasis on being supportive and available. We believe this may be especially valuable for younger students and that these observations apply to courses in all disciplines. This study did not consider external influences, such as isolated living quarters, connection to the campus, and interaction with the community. It would be valuable to study any long-term impacts.

# Revised abstract

Previous research has shown that belonging is essential to academic success, with racially underrepresented students benefiting from a more welcoming environment. We distributed a survey to undergraduate students in STEM courses in 2019 and 2020 to understand how course format and classroom culture influence belonging. Our data showed there was a significant decrease in sense of belonging between years, and that factors such as perceived instructor support and competitiveness affect reported levels of belonging. This study emphasizes the value of in-person learning in creating welcoming spaces and expanding equity in STEM fields.

- We found that between 2019 and 2020, sense of belonging significantly decreased overall.
- We also found that in 2019, first years had the lowest sense of belonging on average compared to all other class years.
- Perceived level of instructor support had significant effects on belonging in 2020 but not in 2019, and furthermore, the relationship between competitiveness and belonging was significant in 2019, but not in 2020.
- In both years, we found that stress related to course content, perceived importance of attending class, motivation to attend class, and personal preparation for class all correlate significantly with sense of belonging.