Have You Heard About This? An Exploration of Instructor Communication About Campus Resources to Students in Biology Courses

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Abstract: Campus resources provide valuable support for students navigating university, in particular historically excluded students. However, not all students may be aware of these resources or be actively encouraged to use them. As students regularly interface with their instructors for consecutive periods of time, instructor communication about campus resources regarding academic, community, wellness, and career and professional support may have positive motivational and psycho-social impacts for all students, especially historically excluded students. Therefore, we explored the types of campus resources that biology instructors communicate with students and whether they are positively correlated with students' sense of belonging, motivation to use resources, and course performance in biology courses. We found that, all else equal, student sense of belonging derived from faculty and staff was positively correlated with the number of types of resources that instructors communicated about in their courses. From the students who reported that their instructors promoted campus resources, most students somewhat or strongly agreed that they were motivated to use career and professional development types of resources. Our results support that instructors have the capability to increase student's cultural wealth by actively communicating various types of campus resources to their students. These results could provide guidance for biology faculty seeking to support students in the classroom and on campus as students are navigating institutions.

Keywords: *Campus resources; instructor communication; motivation; sense of belonging*

Introduction

All students would benefit from increasing access to information, in particular, historically excluded students (Micari & Calkins, 2021). Historically excluded students are groups of student populations that continue to remain under-represented and marginalized in the United States (Byars-Winston et al., 2010). These students include (but are not limited to) women, racial or ethnic minorities, low-income students, and first-generation students (Sánchez Rosas & Pérez, 2015). Students enter institutions with varying knowledge about higher education, for example, continuing-generation and/or higher income college students begin university with more knowledge on how to network with people and/or seek resources in higher education, because they may be more familiar with the way institutions provide resources (Denton et al., 2020; Williamson, 2005). On the other hand, students from communities with lower socioeconomic backgrounds may have less access to resources preparing them on how to succeed in higher education as well as how to persist in their academic majors (Riegle-Crumb et al., 2019).

These equity gaps can contribute to decreased retention in STEM and university, and demonstrate the urgency for institutional change (Chen & Soldner, 2013; Riegle-Crumb et al., 2019). Equity gaps occur when students enter higher education lacking adequate high school preparation, are unaware of campus resources and opportunities, and are navigating spaces in which instructors may have pre-determined perceptions of them due to their background (Grim et al., 2021). Demographic equity gaps that exist in STEM are continuously seen in non-dominant populations (Denton

et al., 2020). For example, chilly institutional climates or negative experiences with instructors decreases student sense of belonging and intent to persist in STEM, in particular for women and students of color (Seymour & Hunter, 2019; Riegle-Crumb et al., 2019).

Ongoing demographic equity gaps and access to resources may be addressed by small changes to how instructors and staff interact with students (Guzzardo et al., 2021; Micari & Calkins, 2021). As instructors interface with students multiple days in a week, they are uniquely positioned to intervene in the demographic equity gaps shown in academic outcomes of many historically excluded students, and to address equity gaps in student knowledge of campus resources. The instructor role can support students beyond their academic needs, helping to remove barriers that may be limiting student academic success (Almeida et al., 2019; Guzzardo et al., 2021). For example, when psychology and public speaking students perceived instructors demonstrating care and empathy (for example being understanding of student circumstances or taking time to explain concepts) students reported a higher sense of belonging (Burk & Pearson, 2022; Kirby & Thomas, 2022).

We posit that instructor communication of resources, when approached with care and empathy, may increase student psychosocial outcomes such as sense of belonging and persistence in STEM. Rather than using a deficit approach which focuses on the role of individual students and how they utilize their student cultural wealth to persist in higher education, we take an anti-deficit approach (Hands, 2020; Nasir & Royston, 2013) and center the role of the institution and instructors on how they serve students (McNair et al., 2022). This study focuses the responsibility of student sense of belonging, resource use motivation, and course performance on the institution and the instructor and explores how students learn about different types of campus resources to help them not only integrate socially but also succeed academically in the classroom.

Theoretical Framework: Community Cultural Wealth

Community cultural wealth is a lens that focuses on the cultural knowledge, social networks, and skills that all students have gained throughout their whole lives (Yosso, 2005). One aspect of community cultural wealth is social capital, or networks and relationships that in turn increase access to resources and opportunities impacting student success (Coleman, 1988). Relevant information entails learning about the campus resources available for students' needs, financial aid information, and/or course requirements to graduate on time (Coleman, 1988). Social capital theory suggests that students receive benefits by acquiring access to campus resources and support from their peer relationships (Almeida et al., 2019). Building a students' social capital with the help of faculty and staff predicts student success in higher education (Almeida et al., 2019). Historically excluded students may struggle as they enter higher education because many enter with limited access to information that is needed to succeed. However, as students expand their on-campus social networks, they increase their social capital and attain information that will help them navigate through college.

Information Gathering

In order to understand how students learn and use that knowledge to build their capital, it is necessary to observe the ways that students gather information about resources from instructors, staff, and other students (Talja, 1997). Information Gathering is a framework that describes the large amount of information that students are exposed to as they are undergoing unique experiences throughout their life (McKenzie, 2003). Socioeconomic status is related to the type of information and resources students have access to, with increased financial capital being positively correlated to knowledge of resources (Savolainen, 1995). Students must gather information about how to succeed academically beyond what the university shares with them because usually that information is not culturally relevant to their unique needs (Pérez, 2017). For example, students may seek communities and/or peers that provide support to help them navigate institutional barriers (e.g., economic, cultural, social, and/or academic) (Belando-Montoro et al., 2022). Institutions and instructors should become more aware of how students enter with diverse backgrounds and/or needs and how such diversity requires more inclusivity and support when providing knowledge of resources and/or organizations that students may utilize for navigation, retention, and success (Belando-Montoro et al., 2022; Grim et al., 2021). Many students, in particular historically excluded students, rely on information gathering from peer networks (e.g., instructors, staff, and students) to learn more about how to persist in higher education (Almeida et al., 2019).

Collegiate Information Networks

Students may receive information from three different types of sources: hot (family and friends with deeper personal relationships), warm (orientation leaders or academic advisors who know students professionally), or cold (general resources available to everyone) (Slack et al., 2014). Historically excluded students come to college with limited "hot" information sources with knowledge about university life; therefore, they rely more on formal relationships that their institution offers (e.g., staff) as they are navigating higher education (Slack et al., 2014).

Cold sources are designed to serve a large student body through mechanisms such as delivering quick answers online by a financial aid FAQs (frequently asked questions) list (Ball & Vincent, 1998). These resources are not tailored to students' specific needs, and often consist of single-exposure information gathering. For example, during orientation, students tend to receive an information overload about campus resources, programs, and clubs at a very fast-pace and consequently students may be unaware of which information to retain to help them with their navigational capital (Grim et al., 2021). Navigational capital is conceptualized around Yosso's (2005) definition in which it is a form of capital that students utilize to maneuver through spaces and systems in higher education that were not made for non-dominant populations to succeed (Denton et al., 2020). Even if students have heard about academic tutoring services during orientation, many students often remain confused on what actions to take next on how to seek and access these specific resources. For students who are new to college, they may forget about what they learned and be afraid or nervous to ask their faculty, staff, and/or peers for their help (Jack, 2019).

An additional importance of hot information gathering is that students tend to trust these sources more as the advice often comes from informal relationships that are typically with individuals who share some of their identities (Torres et al., 2006). At one institution, a Latino/a student organization created a virtual group chat where students were able to actively help each other by asking about how to navigate college, their courses, and/or possible events that they would like to attend together (Grim et al., 2021). This allowed the students to reinforce their social and academic involvement as they formed these strong interpersonal relationships with peers that shared similar identities and/or challenges as they were all pursuing higher education together (Beard, 2021).

Instructors as a Source of Capital for Students

In 1993, Tinto developed a model of student persistence positing that academic interactions with instructors could impact students' academic and social integration (Tinto, 1993). Instructors have an integral influence on many students' experiences not just academically but also beyond their academic needs (Baker, 2006; Guzzardo et al., 2021). Instructors that take on an engaged approach in the classroom may help create an atmosphere that encourages students to actively participate, contributing to increased student comfort with asking questions or seeking help during lecture and outside of class. An individual's experiences in an environment impact their perceived social and academic integration, or their sense of belonging (Hurtado & Carter, 1997) Historically excluded students tend to have a lower sense of belonging in academic environments and are less prone to seek academic support from instructors outside of the classroom (Hurtado et al., 2011). Instructors have the agency to empathize and support students within the classroom to ultimately create a higher sense of belonging at the institution, especially since they are faces of the university that students see weekly (Thiry & Laursen, 2011). Instructors can do this through pedagogy, instructor language, and by being open and willing to help our students persist in STEM.

Inclusive pedagogical techniques that signal openness and empathy on the part of instructors, such as surveys for questions students are too nervous to ask in class can have positive impacts for students (Micari & Calkins, 2021). When students perceive an instructor as more open and willing to help, students not only feel more comfortable to ask for help and support but perform better academically and have an increased sense of belonging in the classroom (Micari & Calkins, 2021). Additionally, active learning pedagogies linked to increased student sense of belonging have also been found to relate to student motivation and increased retention of students in STEM (Xu, 2015). Students value when an instructor is flexible and willing to implement new teaching pedagogies in their classroom because it demonstrates to them that their instructors want them to succeed and gain a higher sense of belonging and self-efficacy in the classroom and the institution (Ballen et al., 2017; Xu, 2015). Finally, instructors can promote inclusivity in their classrooms by the language that they use beyond speaking about course content. This non-content language is known as instructor talk (Harrison et al., 2019; Seidel et al., 2015) and it can influence a student's learning environment and perception (Meaders et al., 2021; Ovid et al., 2021). Therefore, as students perceive instructors as more willing to help with their new pedagogy implementations and empathetic instructor language, this may increase a student's sense of belonging, which can result in increased retention in STEM because they will feel that their instructors care beyond their academic success (Guzzardo et al., 2021).

Classroom pedagogy and instructor language are well documented as recommended approaches for promoting inclusive classrooms (Butler et al., 2021; Cooper et al., 2020; Tracy et al., 2022). However, there is a notable gap in the literature about how students, in particular historically excluded students, learn about and use knowledge to seek campus resources in order to persist in higher education. Instructor empathy and support beyond academics helps further expand students' different forms of capital as they navigate higher education (Vincent Tinto, 2009). Therefore, we posit that instructors' who provide explicit recommendations for campus resources may help students integrate socially into a university setting and succeed academically in the classroom (Figure 1).

In this study we explored the extent to which biology faculty communicate about campus resources, the mechanisms faculty use to communicate about campus resources, and the relationships between faculty communication about campus resources and student outcomes as measured by students' sense of belonging and motivation to use resources. We hypothesized that faculty communication of different types of campus resources may increase student navigational capital and impact students' sense of belonging in STEM.

Methods

Survey Development

To explore instructor communication of campus resources, we wrote survey questions asking students to self-report whether their instructor communicated about campus resources, and to report the ways in which their instructors communicated about campus resources. In order to develop these questions we conducted five think-aloud interviews with undergraduate students and five with faculty to identify common types of campus resources and ways that they were communicated by faculty. These interviews served to establish face validity of items related to instructor communication. After each interview we refined closed-ended select-all-that-apply questions for clarity and comprehensibility.

The survey questions are available in Supplemental Appendix A, and were identical across three quarters of data collection with the exception of two questions. Specifically, during Fall 2021 we provided students a checklist of specific campus resources named by students during think-aloud-interviews. We asked students to self-report whether they had used specific resources (e.g., Teaching and Learning Commons), if their instructor had communicated any of those resources, and if so, how were these resources communicated in a check-list question. In the winter and spring surveys, instead of asking students to self-report instructor communication of each specific example, we asked students to self-report instructor communication of resource types. We provided the same list of examples, and asked students to check (yes/no) to instructor communication of 1) academic; 2) community; 3) health and wellness, and 4) career and professional planning categories of resources. We then asked students, "If their instructor communicated X to them in class? (yes/no), "How did the instructor communicate X,? . We provided a check-list of ways for this question.

Finally, in Winter and Spring 2021 students who reported that their instructors communicated about resources were prompted with an additional question that assessed their motivation on a four-point scale (strongly disagree to strongly agree) to use those resources after instructor communication. This change allowed us to specifically address how instructor communication motivates students.

To assess student sense of belonging, we used validated Likert-type survey items on a six-point scale (strongly disagree to strongly agree) from Hurtado & Carter, 1997 and Knekta et al., 2020. We conducted an exploratory factor analysis to re-validate the items for the biology undergraduate student population at our institution.

Data Collection

This study was approved under the University of California, San Diego IRB protocol #800591. The study was classified as exempt research as it involved survey procedures where information was recorded in ways that identity of the human subjects could not be readily ascertained. We collected two types of data for this study: survey data (including self-reported demographic information) and course performance from two courses: an upper-level genetics course and a lower-level introductory biology course at a large research-intensive university in the western United States. Seven course sections were surveyed in Fall 2021, 10 in Winter 2022, and seven in Spring 2022 (Supplemental Appendix B). The dataset included a total of 10 unique instructors. Across all three quarters, four of these instructors taught multiple course sections per quarter as well as taught more than once during the 2021-2022 academic school year. Specifically, during Fall quarter 2021, Instructor C taught three upper-level course sections. During Winter quarter 2022, Instructor F and Instructor C taught three upper-level course sections. Including, Instructor G taught two lower-level course sections. Lastly, during Spring quarter 2022, Instructor H taught three upper-level course sections.

We disseminated the finalized survey as an assignment on the university learning management system between week 8 and the end of each ten-week quarter. Upon the end of each quarter, faculty shared final student grades from students who consented to participate in the study.

Prior to data analysis we removed students who did not finish the survey, students who were under 18, students who did not consent to share grade data, and students who filled out the survey twice for one course. Initial and final numbers of responses for each quarter are described in Supplemental Appendix B. This process left a total of 3059 responses (1280 responses from Fall 2021, 1042 responses in winter 2022, and 737 responses in Spring 2022). Across courses we received a 72% final overall response rate, with a range of 35–100% across course sections. As students could take the survey once per course they were enrolled in, a small subset of our survey responses was collected from students responding about their experiences in multiple courses.

We calculated overall student demographics by dividing the total number of students from each demographic group by the final number of responses to the survey (Table 1). The population demographics were consistent across quarters (Table 1).

Table 1

Student population

Demographic variable		Fall 2021		Winter 2022		Spring 2022	
		Count	%	Count	%	Count	%
First-generation student status	First-generation	509	40%	399	38%	295	40%
	Continuing generation	750	59%	626	60%	425	58%
	Other/Prefer not to answer	21	1%	17	2%	17	2%
Gender	Women	865	67%	644	62%	496	67%
	Men	388	30%	365	35%	227	31%
	Non-binary	14	1%	17	1.6%	8	1.1%
	Other/Prefer not to answer	13	1%	16	1.4%	6	0.8%
Transfer student status	Transfer student	242	19%	145	14%	103	14%
	Non-transfer student	1037	81%	896	86%	634	86%
	Prefer not to answer	1	0.1%	1	0.1%	0	0%
Total		1280	100%	1042	100%	737	100%

Note: Students were grouped as first-generation college students if neither of their parents had received a Bachelor's degree

Data Analysis

We conducted an exploratory factor analysis (EFA) in JASP Team (2022). JASP (Version 0.16.3) for items related to sense of belonging. Factors were extracted using parallel analysis, and an oblique rotation was used to determine the final factor structure. Scree plot analyses were examined to support the final total factor structure. Based on the plots, we identified a three-factor structure: one factor for students deriving sense of belonging from *within the biology department*, another factor for deriving sense of belonging *from faculty and staff*, and the third factor for deriving sense of belonging from being within *the institution*. The first two factors align with the original factors: social acceptance and valued competency (Knekta et al., 2020). Three survey items did not load onto any of the factors: "I wish I were in a different school,", "I am able to discuss my academic performance with biology faculty or staff outside of class," and "[institution] demonstrates a strong institutional commitment to diversity." These items were excluded from further analysis. With the final structure, each factor contained a minimum of three items (Watkins, 2018).

For each of the three sense of belonging factors, we created a summary score based on the average of all items that loaded onto the factor. We used this score for subsequent statistical analyses and visualizations. Linear regressions and ANOVA analyses were conducted in JASP to test for differences in sense of belonging.

Data visualization was conducted in R using the ggplot2 (Wickham, 2016), likert (Bryer & Speerschneider, 2016) and gplots (Warnes et al., 2020) packages.

Results

Overall, students agree that instructors communicate about campus resources

We first explored if instructors were communicating about four types of campus resources (academic, career, community, and health) in their courses to their students. For each course section, we calculated the percent of students who reported that their instructors communicated about each resource. Across all quarters, students overwhelmingly agreed that their instructors shared information about academic support resources (Figure 1). On average, within course sections students were in high agreement, with course sections during fall 2021 (m = 93%, stdev = 5%), winter 2022 (m = 90%, stdev = 4%), and spring 2022 (m = 88%, stdev = 5%) agreeing.

There was less agreement among students within each course section regarding whether their instructors communicated about career, community, and health resources. Overall, students across sections reported higher overall communication of resources in winter quarter compared to fall and spring quarter.

Figure 1

Instructor communication about campus resources
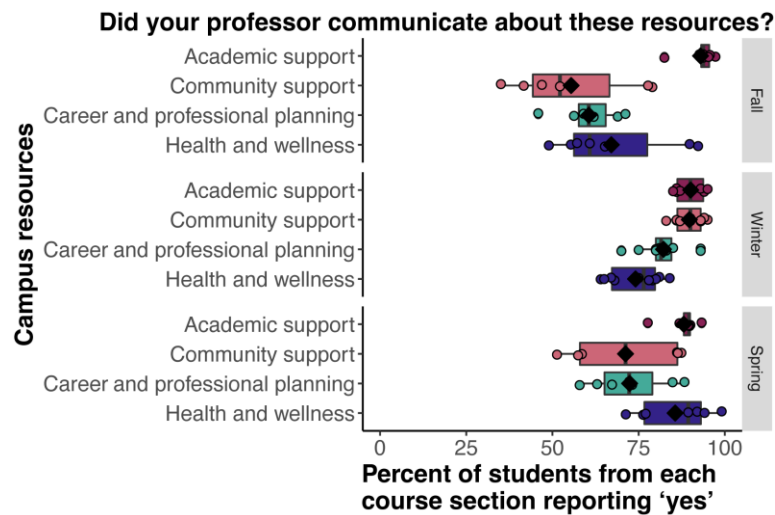
Note: Each circle represents the percent of students from one course section. Diamonds represent the mean; black lines represent the median.

Instructors primarily communicate about campus resources via syllabi and canvas

After we established that instructors do communicate about various resources, we explored the mechanisms used by those instructors. We calculated the percentage of students who reported that their instructors communicated resources via different methods of communication. Students agreed that instructors rarely communicated resources via office hours or extra 1-to-1 meetings, with ~92-98% of students across courses reporting that these mechanisms were not used (Figure 2). The most common instructor communication of resources was via syllabi, during the first day of class,

or via the course learning management system, with some instructor variation across sections. In fall quarter course sections, students reported that resources were communicated less than winter and spring quarter courses.

Figure 2

*Mechanisms by which instructors communicate resources*
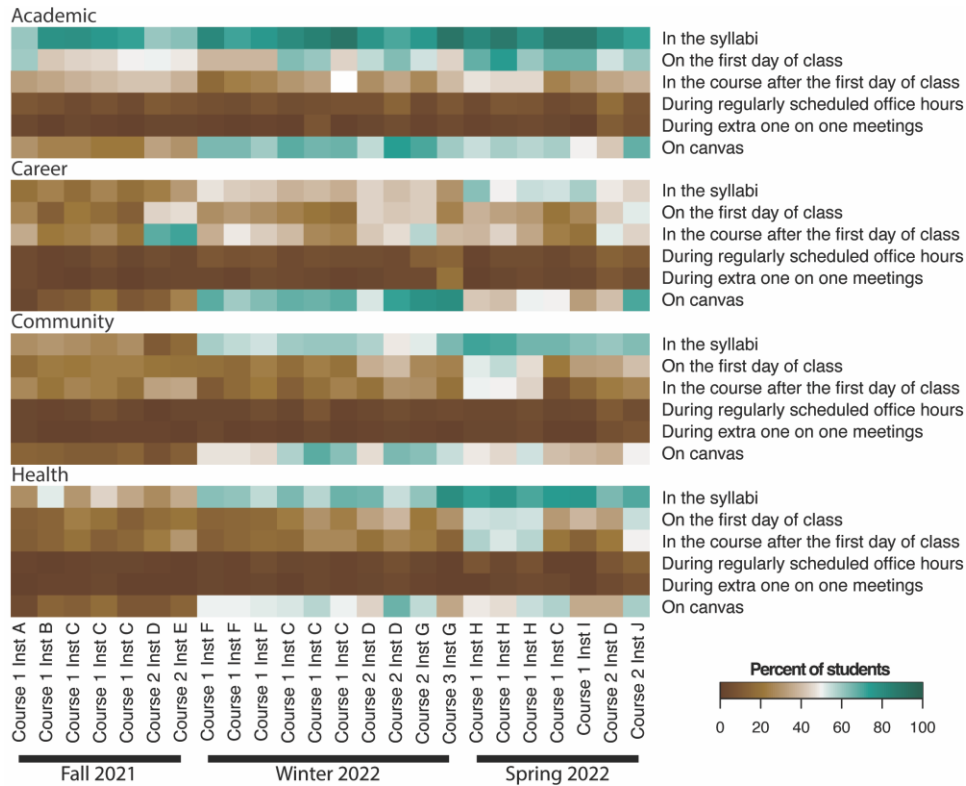
Note: Heatmap depicting the percent of students from each course section that reported their instructors communicated resources via various methods. Scale: 0-100, where 100 represents 100% of the students.

Instructor communication of resources has mixed motivational effects for students

During the winter and spring quarters of 2022, we asked all students who reported that their instructors communicated about resources about the impacts of that communication on their motivation to use campus resources. From the students who reported that their instructors promoted campus resources, most students (81% during Winter 2022 and 74% during Spring 2022) somewhat or strongly agreed that they were motivated to use career and professional development resources (Figure 3). Even though academic resources are communicated the most during class by instructors, students are more motivated to use other resources, such as career and professional development resources.
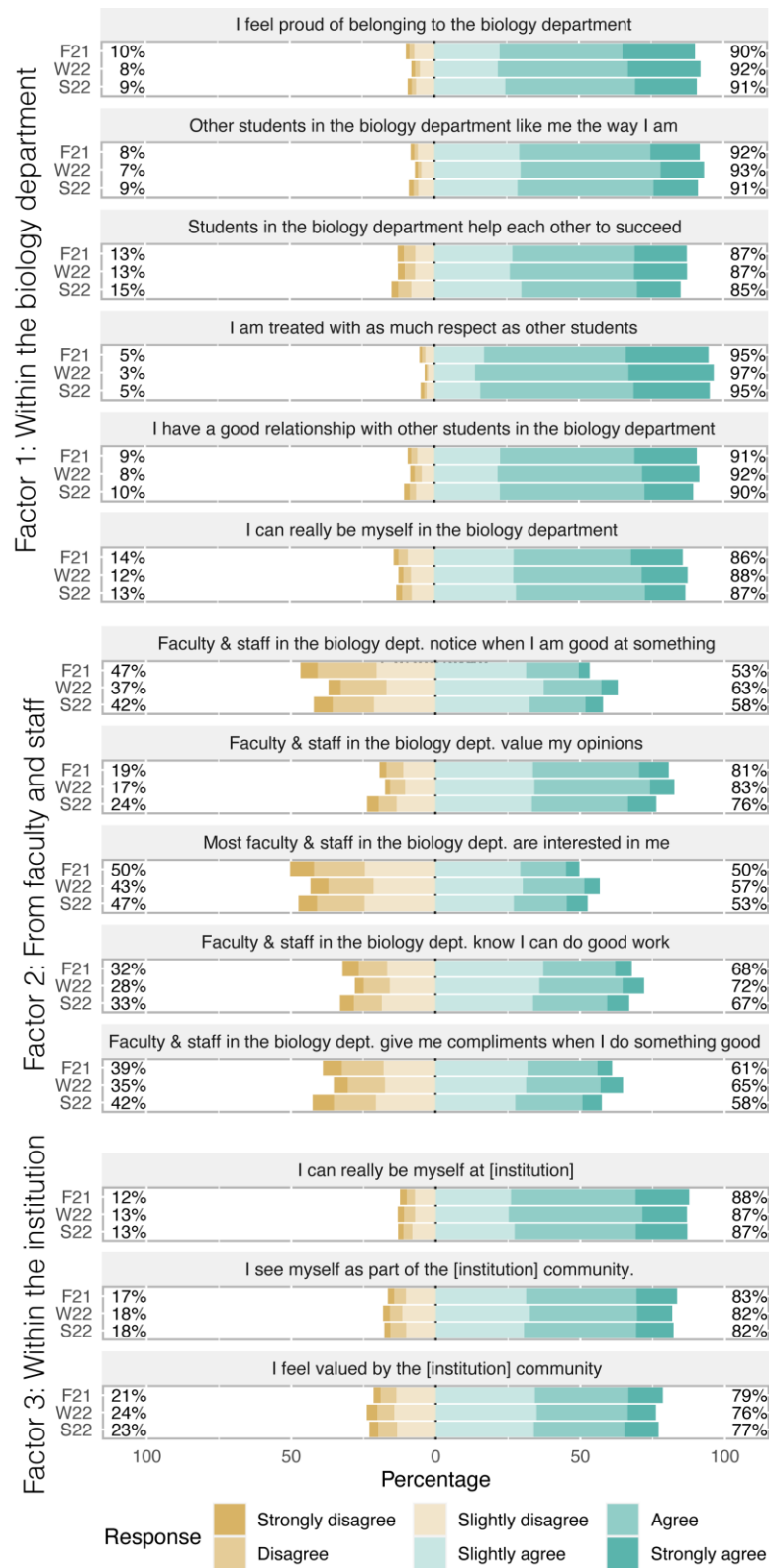
Figure 3

Resource use motivation
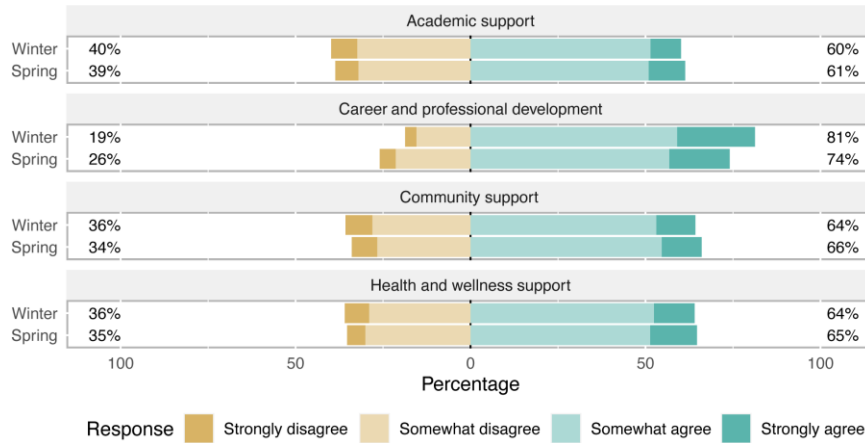
Note: Left percentages represent the total percent of students reporting disagreement (strongly or somewhat disagree), right percentages represent the total percent of students reporting agreement (strongly agree or somewhat agree).

Student sense of belonging is derived from three sources

We surveyed students regarding their sense of belonging using 14 validated Likert-type items on a 6-point scale. For all items, at least 50% of students agreed, slightly agreed, or strongly agreed, indicating that most students felt a sense of belonging. Factor analysis revealed a three-factor structure, with six items loading onto a factor related to within the biology department, five items loading onto a factor related to faculty and staff, and three items loading onto a factor related to the university (Table 2, Figure 4). Using a promax rotation, all items separated with factor loadings greater than 0.5. The factor structure was consistent across all three quarters. This structure explained ~60-64% of variance in the data across each of the quarters. Cronbach's alpha values ranged from 0.88-0.93, illustrating the high internal consistency for all items in each factor.

Figure 4

Student sense of belonging as measured by Likert-type items

Note: Student responses to individual Likert-type items, disaggregated by quarter and arranged by factor. Left percentages represent the total percent of students reporting disagreement (strongly disagree, disagree, slightly disagree), right percentages represent the total percent of students reporting agreement (strongly agree, agree, or slightly agree).

Table 2

Factor loadings and cronbach's alpha values from exploratory factor analysis (EFA)

| | Factor loading | | | | | | | | | Descriptives | |
| | Fall 2021 | | | Winter 2022 | | | Spring 2022 | | | | |
	1	2	3	1	2	3	1	2	3	Mean	SD
Factor 1: From the biology department											
I have a good relationship with other students in the biology department.	0.916			0.817			0.911			4.738	1.005
Other students in the biology department like me the way I am.	0.891			0.865			0.881			4.670	0.935
I am treated with as much respect as other students.	0.804			0.832			0.824			5.01	0.876
I can really be myself in the biology department	0.764			0.838			0.873			4.556	1.064
I feel proud of belonging to the biology department.	0.747			0.775			0.691			4.791	1.01
Students in the biology department help each other to succeed.	0.725			0.629			0.670			4.553	1.113
Factor 2: From faculty and staff											
Most faculty and staff in the biology department are interested in me.		0.914			0.918			0.966		3.513	1.30
Faculty and staff in the biology department notice when I am good at something.		0.898			0.856			0.925		3.585	1.262
Faculty and staff in the biology department know I can do good work.		0.84			0.851			0.875		3.905	1.215
Faculty and staff in the biology department give me compliments when I do something good.		0.801			0.809			0.878		3.725	1.31
Faculty and staff in the biology department value my opinions.		0.602			0.637			0.675		4.256	1.117
Factor 3: From the institution											
I see myself as part of the [institution] community.			0.841			0.792			0.631	4.379	1.114
I feel valued by the [institution] community.			0.76			0.813			0.774	4.196	1.167
I can really be myself at [institution].			0.605			0.578			0.782	4.582	1.09
Unrotated extracted sum of squares loadings	7.691	1.659	0.819	8.132	1.319	0.85	8.241	1.61	0.981		
Proportion of variance	0.452	0.098	0.048	0.478	0.078	0.06	0.485	0.095	0.058		
Cronbach's alpha	0.903	0.895	0.869	0.899	0.903	0.881	0.905	0.93	0.885		

Note: Descriptives calculated from N = 3059 student responses across all three quarters

Based on the factors we calculated a summary score for each of the three types of aspects of sense of belonging for each student and these scores were generated by averaging student responses to the items in Figure 4. Overall, students reported a high sense of belonging derived from within the biology department and the institution across all three quarters with an approximate 77 to 97% student agreement to all the items within the biology department and for within the institution. However, there was more variation for items that loaded onto how faculty and staff contribute to students' sense of belonging, with some greater percentages of students disagreeing with the statements. On average, students experienced a lower sense of belonging derived from faculty and staff (M = 3.8; SD = 1.1) compared to peers (M = 4.7; SD = 0.8) and at the university (M = 4.4; SD = 1.0) (Figure 5).

Figure 5

Student overall sense of belonging
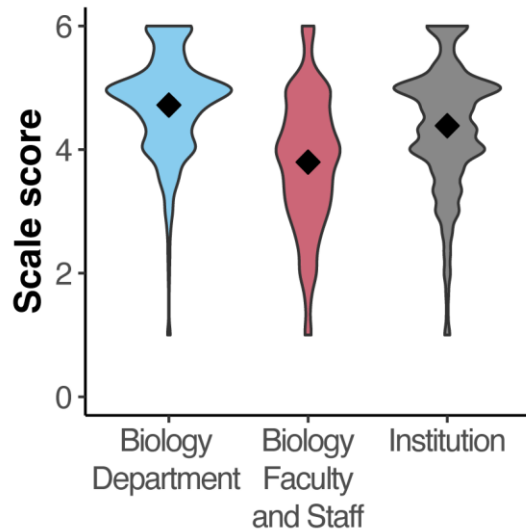
Note: Diamonds represent mean values.

Instructor communication of resources and student course performance are predictors for student sense of belonging

Students experienced a lower sense of belonging derived from faculty and staff across all three quarters, and students varied the most in their responses to these items (Figure 5, Table 2). As faculty interact with students multiple days during the week, they have the capability to promote student sense of belonging with their pedagogy and instructional choices such as communicating about various types of campus resources (e.g. academic, career, community, and health). Therefore, we hypothesized that there may be a positive relationship between instructor communication of resources and student sense of belonging. We measured the number of types of resources reported by students (e.g., each student could report a value between 0-4). We included this number as a predictor in three linear regression models, one for each factor of sense of belonging (Table 3). In each model we included student demographics (gender, first-generation college student status, and transfer student status) as well as students' final course grades, as course performance may be a contributor to students' sense of belonging. Final grades were a significant predictor for students' sense of belonging across all three factors, with each one-percent increase in grade being associated with a 0.01 increase in sense of belonging. Additionally, a one-unit increase in the number of resources faculty spoke about was associated with an increase of ~0.1 sense of belonging. No demographic variables were significant predictors, except for male students reporting a significantly higher sense of belonging than their female student peers for sense of belonging derived from factor 2: from faculty and staff. The proportion of variance for each sense of belonging factor explained by the models ranged from 2.5% and 6.6%.

Table 3

Estimated coefficients for models examining the impact of various predictors on student sense of belonging.

Predictor	Factor 1: From the biology department				Factor 2: From faculty and staff				Factor 3: From the institution			
	B	**Std Error**	**t**	**p**	**B**	**Std Error**	**t**	**p**	**B**	**Std Error**	**t**	**p**
(Mean intercept)	3.27	0.141	23.155	< .001***	2.217	0.182	12.21	< .001***	3.294	0.176	18.765	< .001***
N of resource types	0.107	0.013	8.357	< .001***	0.174	0.016	10.565	< .001***	0.107	0.016	6.761	< .001***
Gender (Male)	-0.037	0.032	-1.15	0.249	0.116	0.041	2.845	0.004**	-0.003	0.04	-0.073	0.942
Gender (Non-binary)	-0.053	0.133	-0.40	0.69	-0.091	0.171	-0.535	0.593	-0.024	0.165	-0.147	0.883
Continuing generation	0.024	0.031	0.76	0.447	0.012	0.04	0.307	0.759	-0.013	0.038	-0.344	0.731
Non-transfer student	-0.016	0.043	-0.38	0.702	-0.003	0.055	-0.006	0.956	-0.091	0.053	-1.704	0.089
Final course grades	0.013	0.002	7.72	< .001***	0.012	0.002	5.365	< .001***	0.01	0.002	4.67	< .001***
R^2	0.05				0.066				0.025			

Notes:

The intercept represents a female, first-generation, transfer student who reported their instructor communicated about 0 resources and received a 0 as their final grade.

*** p values < 0.01; *** < 0.001*

Instructor communication of resources and student sense of belonging within a department are predictors for course performance

Increased academic performance predicts student sense of belonging, but student sense of belonging may be a predictor for increased academic performance. We ran an additional fourth linear regression model using final course grades as the dependent variable, and included student sense of belonging, demographics, and reported instructor communication of resources as predictors (Table 4). This model explained 16.5% of the variation in the dataset. Instructor communication of resource types was associated with higher student final course grades. Of the student predictors, a student's sense of belonging from within the biology department was a positive and significant predictor of final course grades. Additionally, non-transfer students, continuing generation students, and male students all received higher final course grades than their peers. These findings illustrate that while sense of belonging and instructor communication are associated with student academic performance, there are remaining equity gaps that must be addressed in the classroom.

Table 4

Estimated coefficients for models examining the impact of various predictors on student final course grades

	B	**Standard Error**	**t**	**p**
(Intercept)	71.144	1.059	67.2	< .001***
Factor 1	1.462	0.278	5.25	< .001***
Factor 2	0.287	0.193	1.489	0.137
Factor 3	-0.143	0.217	-0.658	0.511
Non-transfer student	7.742	0.449	17.25	< .001***
Continuing generation	3.263	0.334	9.774	< .001***
Gender (Male)	1.076	0.349	3.087	0.002**
Gender (Non-binary)	-0.853	1.453	-0.587	0.557
N of resource types	0.489	0.143	3.432	< .001***
R^2				0.164

Notes:

The intercept represents a female, first-generation, transfer student who reported their instructor communicated about 0 resources, reported a 0

for all three factors of sense of belonging and received a 71 as their final grade.

Discussions

In our study, biology instructors most communicated about academic campus resources (Figure 1), and primarily communicated about resources via syllabi and on canvas (Figure 2). Even though more instructors communicated about academic resources than career and professional development types of resources, students reported higher motivation to use career and professional development resources that were promoted by their instructors (Figure 3). Instructors may have positive impacts beyond content instruction, especially as they may be the most regular campus professionals that students interact with throughout their time at university (Thiry & Laursen, 2011). Programs that offer faculty, staff, or peer mentorship provide social capital for students and can help them gain the resources to succeed in higher education. However, these programs may not be available or used by all students. Instructors that provide mentorship in class may increase access to institutional knowledge for students that may not be affiliated with such programs. Mentoring not only contributes to a student's academic success, but also with their social integration as they build peer relationships with people that are within their community of practice (e.g faculty, graduate students, and/or undergraduate peers) (Schwartz et al., 2018; Tinto, 2012).

We found that instructor communication of resources was positively associated with student sense of belonging. However, instructors mainly communicated about resources via asynchronous mechanisms. In-class time, office hours and one-on-one meetings all are face-to-face opportunities to connect with students and convey the importance of using various resources. Office hours typically are only viewed as opportunities to review content, however could be reframed as an opportunity to network with faculty beyond academics so students may feel more welcome and/or comfortable to attend (Smith et al., 2017).

Students reported their lowest average sense of belonging derived from faculty and staff (Figures 4 and 5, Table 2). We found that when instructors communicated about resources this was associated with significantly higher student sense of belonging (Table 3). Notably, the only statistically meaningful difference in a students' sense of belonging

related to demographic identity was observed in the male student population, which derived a higher sense of belonging from faculty and staff compared to women. Gender-related differences in student sense of belonging in STEM are well documented (Rainey et al., 2018), and influence student persistence. Increased communication of resources from faculty is associated with benefits for all students with their sense of belonging and may in particular help women in the classroom.

While we identified an additional source of positive impact instructors may have on students' sense of belonging and academic outcomes, our data further emphasized the statistically significant demographic academic grade equity gaps that continue in STEM for historically excluded students. Specifically, non-transfer students, continuing-generation students, and male students all received higher final grades than their peers (Table 4). Therefore, it is important for instructors to understand that students value feeling that their instructors are comfortable with receiving questions so they may feel encouraged to seek support based on their specific needs to succeed as a student (Micari & Calkins, 2021).

Instructors should be aware that students enter classrooms with diverse community cultural wealth (Nasir & Royston, 2013). Students are utilizing their unique lived experiences, cultural, and demographic backgrounds to bridge their experiences as they are navigating higher education in STEM. Students should not be viewed using a deficit approach, assuming that they are lacking due to their cultural and social capital. Instead, instructors should utilize the opportunity to value the different forms of capital that students bring into the classroom and empower their individuality. When instructors adapt to their students' unique needs and show them that they care for them beyond academics (Nasir and De Royston, 2013; Almeida et al., 2021; Guzzardo et al., 2021) students experience a higher sense of belonging (Seymour & Hunter, 2019).

Previous literature has explored the various ways instructors can foster inclusive climates and positive impacts on student outcomes, for example instructor openness to questions positively correlating with increased students' help-seeking behaviors (Micari & Calkins, 2021). Students value when instructors provide support *beyond* academic success. For example, students appreciate mentorship and advising and instructors who are willing to listen and understand the present barriers that are inhibiting students from doing well in their course (Guzzardo et al., 2021). Positively phrased non-content instructor talk, or language that goes beyond course content, can impact student perceptions of instructors (Meaders et al., 2021; Ovid et al., 2021). When instructors communicate about various types of campus resources, students may feel that their instructors care about their student capital and navigation of the university. Communication of resources signals being a caring faculty member, which may not only increase student sense of belonging but be motivating for students, resulting in the significant but weak association in student course performance in the classroom (Table 4) (Grim et al., 2021; Guzzardo et al., 2021). As a result, our findings build upon previous studies that demonstrated the positive impact instructors may have with their students. Our findings show that instructor communication about non-academic resources is positively associated with an increase in student sense

belonging. This increase in student sense of belonging may indicate an increased sense of capital as the students navigate the institution.

Limitations

There are a few notable limitations to consider when interpreting our findings, which invite future studies. First, although our data supports that there is a relationship between instructor communication of types of resources, student sense of belonging, it is important to consider that our dataset did not measure the number of times instructors communicated about resource types or other aspects of the instructor's teaching. Therefore, it is unknown if instructors were providing active and consistent communication of various types of resources in their classroom throughout the quarter, or if higher communication of resource types is a representative proxy for general inclusive teaching practices. Further work should also include student interviews to explore the nature of this positive relationship, and to identify the mechanisms of instructor communication that resonate with students the most – for example, whether in-person verbal communication or asynchronous promotion (e.g. syllabi or course messages) are more effective at promoting student sense of belonging and resource motivation. Additionally, in this study we did not ask students to self-identify their race or ethnicity, and thus instructor communication of resources and impacts for students historically excluded from STEM based on their racial or ethnic identities remains an open question.

A separate limitation to our study was the inconsistent delivery of courses due to the ongoing COVID-19 pandemic. Fall 2021 and Spring 2022 were in-person terms, but Winter 2022 was a hybrid term with the first four weeks meeting online. Students may have noticed their instructors communicating resources on syllabi and canvas more due to remote instruction, or instructors may have communicated about more campus resources due to the challenges of the term for students. Future work should explore from an instructor perspective if they increased communication of various campus resources due to the pandemic, and from a student perspective which mechanisms of communication are best noticed by students.

Finally, we surveyed each course at the end of the term, and as such are unable to identify how sense of belonging for each student changed over the course of the term. Future studies should use pre- post- methodology and explore if there is a relationship between instructor communication of resources and changes in student sense of belonging derived from faculty and staff.

Conclusion

We recommend that instructors be informed of the different types of on-campus resources (e.g., communities based on one's ethnic/cultural background) that are available for students. We also recommend that instructors also actively share on-campus information with their students with a goal of helping students find communities of like-minded people that may facilitate their higher education integration (Grim et al., 2021). Our work showcases how low-time and energy investment strategies such as communicating resources can have high impacts for student outcomes in terms of student sense of belonging and academic performance.

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Appendix

Supplemental Appendix A: Survey items

	FALL	WINTER	SPRING
Q1	What course section are you in?		
Q2	Are you a transfer student (yes/no)?		
Q3	Did your instructor communicate about **[example resources]** resources to you in class?	Has your instructor communicated **[example resources]** to you in class (yes/no)?	Has your instructor communicated **[example resources]** to you in class (yes/no)?
Q4	How did your instructor communicate about **[example resources]**?	How did your instructor communicate about **[example resources]**?	How did your instructor communicate about **[example resources]**?
Q5		Please select your level of agreement with the following statement: After my instructor communicated about **[example resources]** in class, I was motivated to use them	Please select your level of agreement with the following statement: After my instructor communicated about **[example resources]** in class, I was motivated to use them
Q6	Please select the option that best fits your level of agreement with each of the following statements. For this set of questions, staff includes the instructional team (instructional assistants and teaching assistants). (**sense of belonging statements from validated surveys**) -Faculty and staff in the biology department notice when I am good at something.* -Faculty and staff in the biology department value my opinions.* -Most faculty and staff in the biology department are interested in me.* -Faculty and staff in the biology department know I can do good work. * -Faculty and staff in the biology department give me compliments when I do something good.* -Students in the biology department help each other to succeed.*		

	-I am treated with as much respect as other students.*
	-I have a good relationship with other students in the biology department.*
	-I can really be myself in the biology department.*
	-I feel proud of belonging to the biology department.*
	-Other students in the biology department like me the way I am.*
	-I am able to discuss my academic performance with biology faculty or staff outside of class.*
	-[institution] demonstrates a strong institutional commitment to diversity. (own)
	-I can really be myself at [institution].*
	-I wish I were in a different school.*
	-I see myself as part of the [institution] community.+
	-I feel valued by the [institution] community. (own)
Q7	I most closely identify as:
	-Female
	-Male
	-Non-binary
	-Other
	-Prefer not to answer
Q8	Highest level of education completed by at least one of your parents:
	-Did not complete high school
	-High school/GED
	-Some college (but did not complete college)
	-Associate's degree (2-year degree)
	-Bachelor's degree
	-Master's degree
	-Advanced graduate degree (e.g. DVM, MD, PhD)
	-All parental education was obtained outside of the US
	-Unknown
	-Prefer not to answer

Notes:

Q5 items were on a four-point agreement scale; Q6 iterms were on a six-point agreement scale

* represents items adapted from Knekta et al., 2020; + represents items adapted from Hurtado et al, 1997

Supplemental Appendix B: Data processing and response rates

Data processing	Fall 2021	Winter 2022	Spring 2022
Initial total number of responses	1597	1210	858
Students who did not finish	93	32	24
Students who were under 18	24	10	5
Students who did not consent to share grade data	178	113	88
Removed duplicate responses within each course section	22	13	4
Final number of responses (survey data)	1280	1042	737
Final number of responses with grade data	1255	1025	737

Quarter	Course	Course level	N of student responses	Response rate
Fall 2021	Course 1 Instructor A	Upper	194	84%
Fall 2021	Course 1 Instructor B	Upper	206	75%
Fall 2021	Course 1 Instructor C	Upper	147	98%
Fall 2021	Course 1 Instructor C	Upper	92	62%
Fall 2021	Course 1 Instructor C	Upper	96	62%
Fall 2021	Course 2 Instructor D	Lower	271	73%
Fall 2021	Course 2 Instructor E	Lower	274	72%
Winter 2022	Course 1 Instructor F	Upper	150	97%
Winter 2022	Course 1 Instructor F	Upper	133	86%
Winter 2022	Course 1 Instructor F	Upper	127	84%
Winter 2022	Course 1 Instructor C	Upper	77	100%
Winter 2022	Course 1 Instructor C	Upper	67	61%
Winter 2022	Course 1 Instructor C	Upper	51	68%

Winter 2022	Course 2 Instructor D	Lower	139	74%
Winter 2022	Course 2 Instructor E	Lower	148	82%
Winter 2022	Course 2 Instructor G	Lower	130	70%
Winter 2022	Course 2 Instructor G	Lower	20	50%
Spring 2022	Course 1 Instructor H	Upper	137	73%
Spring 2022	Course 1 Instructor H	Upper	119	63%
Spring 2022	Course 1 Instructor H	Upper	110	58%
Spring 2022	Course 1 Instructor C	Upper	76	67%
Spring 2022	Course 1 Instructor I	Upper	135	76%
Spring 2022	Course 2 Instructor D	Lower	94	53%
Spring 2022	Course 2 Instructor J	Lower	66	

Notes:

Response rates were calculated by dividing the number of student responses out of total course enrollment

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