SYSTEMS THINKING IN STUDENT RETENTION AND STEM PERSISTENCE: A HOLISTIC APPROACH TO NAVIGATING CHALLENGES AND IMPLEMENTING TARGETED SOLUTIONS IN HIGHER EDUCATION

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Decades of research focused on student retention in higher education have produced theoretical models which, despite being valuable, fail to characterize the convoluted nature of factors influencing retention outcomes. This thesis proposes a novel approach to understanding and addressing challenges of retention utilizing systems thinking. Through this method, institutions and departments are better able to identify areas of need and implement targeted solutions for the individualized nature of the problem. This systems map offers a more holistic perspective than the traditional siloed retention interventions. Implementing a student-centric approach, such as in virtual community support programs, or an institutional-centric approach, such as in a departmental climate survey, allows universities to strike a balance for the multifaceted challenges of addressing retention gaps. Integrating these approaches via the proposed systems map presents a promising avenue to tackle the ever-growing challenge of student retention within higher education.

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DEDICATION

This thesis is dedicated to Grandpa Frank, who watched me start grad school but never got to see me finish. He was an educator, a lover of birds, and a plant enthusiast; but most importantly, he was one of my biggest supporters. I think he would have been proud.

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CHAPTER 1: BUILDING A SYSTEMS MAP TO CHARACTERIZE STUDENT RETENTION IN HIGHER EDUCATION[1]

Introduction

Workforce development and preparation for careers in Science, Technology, Engineering, and Math (STEM) is vital to both individual success and maintaining the United States (US) economy. In 2021, it was estimated that STEM jobs comprised almost a quarter of the national workforce (1), although the US Bureau of Labor Statistics estimates the 2022 STEM employment is about 6.3% of all occupations (2). Despite these large discrepancies, these industries have been on the rise for decades. It is estimated that STEM employment grew at a rate of six times greater than that of non-STEM occupation employment from 2005-2015 (3). While STEM employment only made up a small fraction of the national employment, there are some industries where STEM jobs account for over half the workforce (4). In fact, North Dakota has been ranked among the highest states with STEM employment rate growth, taking first in 2017 with 26%, over twice the national average at the time (4).

Despite the workforce needs, the academic progression of students in the US does not match the demand. According to the US Department of Commerce, the majority of students earning bachelor's degrees in STEM disciplines are choosing careers in non-STEM fields (62.1%), with the remainder working in either STEM or STEM-related fields (5). The President's Council of Advisors on Science and Technology report that higher education institutions in the US need to increase students receiving STEM degrees by 34% annually (6).

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[1] The material in this chapter was co-authored by Kaylee M. Weigel and Danielle LJ Condry. Kaylee M. Weigel had the primary responsibility of collecting and analyzing literature for this review, developing the systems thinking map, and drawing conclusions. Kaylee M. Weigel also drafted and revised all versions of this chapter. Danielle LJ Condry served as an advisor, proofread each version, and provided guidance as to methods of systems design.

Higher education institutions play a key role in the preparation of students for workforce, specifically in STEM. High research universities (often referred to as "R1" per the Carnegie-classification) contribute to about 75% of academic research and development and are a large producer of STEM degrees in the US (7). Since a four-year degree is one of the primary pathways for entering the STEM workforce, students persisting through their degree programs is vital to fulfilling these workforce needs.

An important aspect of students successfully obtaining their degree in a STEM discipline is their retention and persistence through the university and program. Commonly referred to as the "ever-narrowing pipeline", trajectory through a STEM degree is seen as linear with fewer students enrolled at each successive milestone (8). While this metaphor may not be the most comprehensive in terms of the true pathway to a STEM degree (8, 9), it highlights a major problem: fewer students are receiving STEM degrees than those declaring a STEM path. Addressing these "leaks" of students is vital for improving the retention and persistence of students through their degree pathways and into the workforce. Retention of students in their academic disciplines and persistence in STEM fields post-graduation into the workforce is important for career preparation and fulfilling the workforce needs of the growing market.

It is important at this point to denote the difference between persistence and retention. Although often used interchangeably, retention and persistence are subject to change on their meaning and influence. The National Student Clearinghouse measures persistence as the rate of students returning to any higher education institution, while retention is returning to their same institution (10). However, a more appropriate scope would be the lens from which the situation is looked: retention should be a metric used at the institutional level, whereas persistence is more appropriate for a student-centric approach. If persistence is a student-centric approach, then the

precursor effects that influence persistence are internal factors, specific to each student. If retention is an institutional approach, the influences are external factors, specific to each institution. Oftentimes included with retention research is attrition, which is conceptually the opposite of being retained: attrition is leaving the environment, whereas retention is staying in the environment. In terms of higher education, attrition would be analogous to dropout or transfer, where retention is remaining at the institution. Attrition can be viewed as the result of failure to persist, or failure to be retained. Figure 1 displays a hypothesized model of this process. While persistence and retention can influence each other, a negative result of persistence or retention influences attrition status.

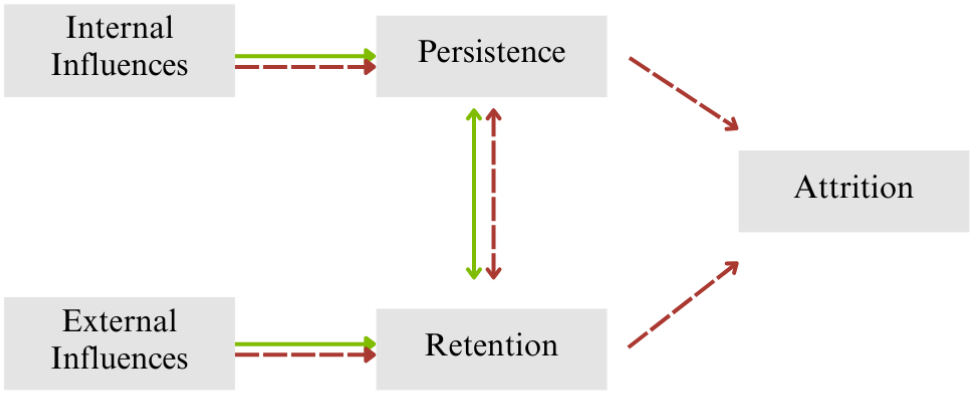

Figure 1. Interconnection of retention, persistence, and attrition.
Green solid arrows denote positive influences, and red dashed arrows denote negative influences.

When examining retention in higher education, it is important to note that this process can be discipline specific. The National Clearinghouse reported that fall to fall undergraduate retention rates differed by major: Engineering reported a retention rate of 85.3%, while Business Management reported a rate of 77.1% (10). Although two specific examples, this discrepancy alludes to the underlying differences of majors across an academic institution. Similarly, retention rates of specific disciplines vary by institution: four-year nonprofit institutions tend to have slightly lower average retention rates than four-year for-profit institutions, although both

have higher retention rates by almost 20% (10). These variances allude to the larger picture of retention – it's highly variable and fluctuates based on the environment being examined. Retention has been extensively studied for decades, attempting to characterize the multitude of influences despite these different settings.

Retention Theoretical Frameworks

Retention in higher education has been closely examined for many years. Retention theoretical models have been hypothesized, tested, and re-evaluated with retention as the focus. Among some of the earliest scientists within the field of retention research, William Spady was a pioneer, being the first to incorporate sociological theory into a student retention theoretical model (11). Spady related student attrition, referring to students leaving their program of study or institution, to Durkheim's theory of suicide (1951). Durkheim found that the likelihood of suicide would increase with the absence of social integration, specifically in inadequate moral consciousness and inadequate collective affiliation (12). Spady (1970) drew upon these components and made comparisons of his own – relating moral consciousness to normal congruence, collective affiliation to friendship support, role performance to academic performance (grades), and identifying group norms to intellectual development (13). Spady used these four main components, in addition to social integration, to serve as the backbone of his model: The Undergraduate Dropout Process Model (see Figure 2). This model was based on a definition of dropout that encompasses any student that leaves an institution for which they are matriculated.

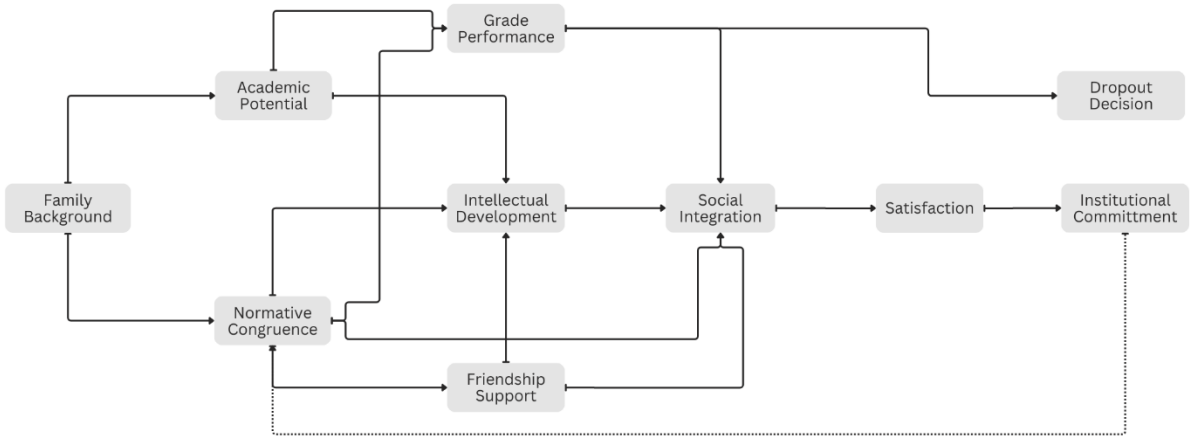

Figure 2. Spady's Undergraduate Dropout Process Model.
Adapted from Spady (1970).

Despite the novel nature of Spady's Dropout Process Model, Vincent Tinto's Institutional Departure Model is arguably the most cited and influential (11). Tinto's 1975 model utilizes sociological theory, mainly drawing upon Durkheim's Theory of Suicide and previous work of other researchers in the field to build his theoretical model(14). Durkheim's theory relates suicide rates to societal integration, where lack of integration leads to higher rates of suicide (12). Tinto builds upon Spady's comparison that dropout is analogous to suicide in society if higher education is viewed as a social system (13). This theoretical model views dropout as a longitudinal process between an individual and the system the individual experiences, and how commitments influence dropout decisions (Figure 3). Tinto identified two main environmental factors: academic system and social system and leaving is rooted in one or the other. This model was later adapted to link classrooms, learning, and persistence (Figure 4) (15). Tinto's model is alike Spady's where dropout is defined by students leaving their institution, regardless of transfer status.

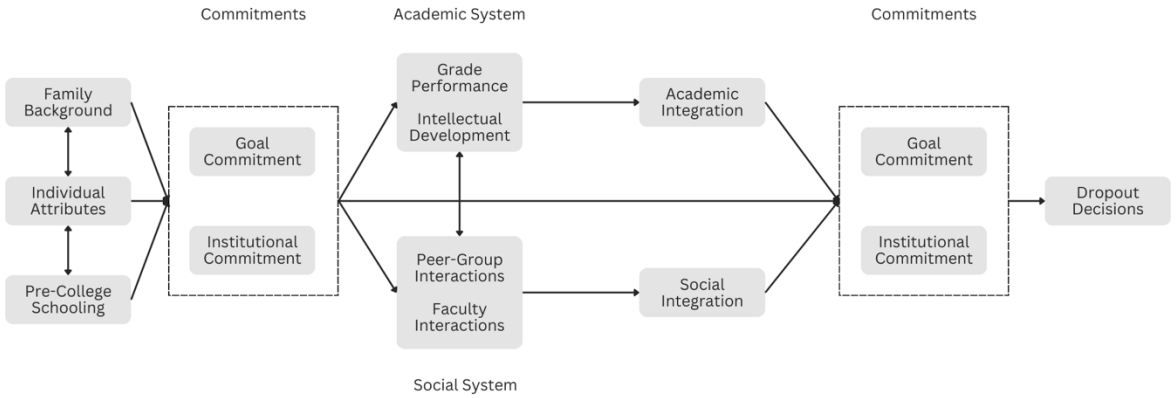

Figure 3. Tinto's Institutional Departure Model.
Adapted from Tinto (1975).

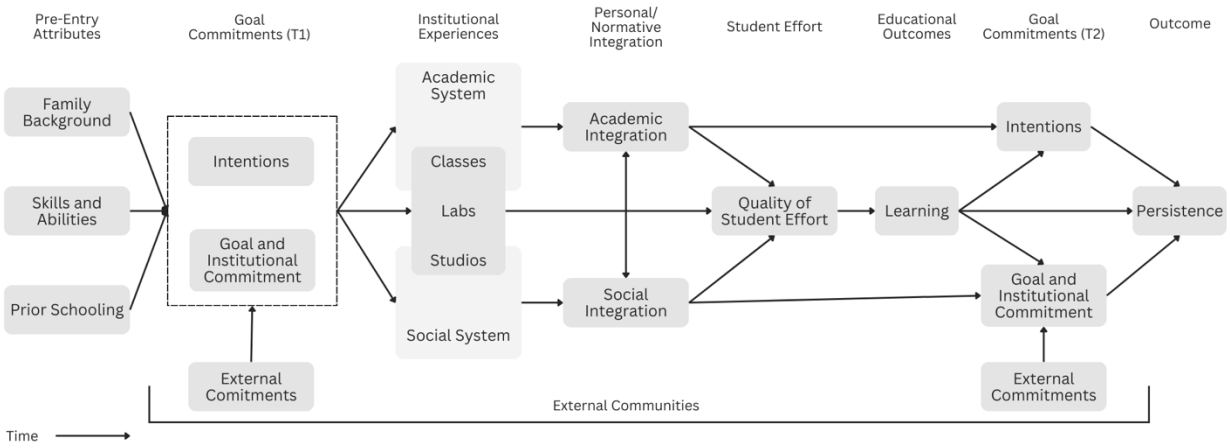

Figure 4. Tinto's adapted Model of Institutional Departure.
Adapted from Tinto (1977). *Classrooms as Communities: Exploring the Educational Character of Student Persistence,* Vincent Tinto*,* The Journal of Higher Education, reprinted by permission of Informa UK Limited, trading as Taylor & Francis Group, www.tandfonline.com.

Following the work of Spady and Tinto, John Bean theorized a model in the early 1980s which was the first to identify the similarities in both students and employees leaving an organization (11). Bean criticized the work of Spady and Tinto as their models and variables were incompatible for path analysis. Bean's Model of Student Attrition (16) drew on research regarding employee turnover (published by James Price regarding work organization turnover (17)) to establish determinants of student attrition, relying on the assumption that student attrition

and employee turnover are analogous. A casual model was developed and tested, and final models were constructed for women and men based on outcomes (Figure 5). Both models found institutional commitment as the largest influence of student attrition, which was consistent with the work of Spady and Tinto. Bean also found that satisfaction was a significant influence for women, but unrelated to institutional commitment for men.

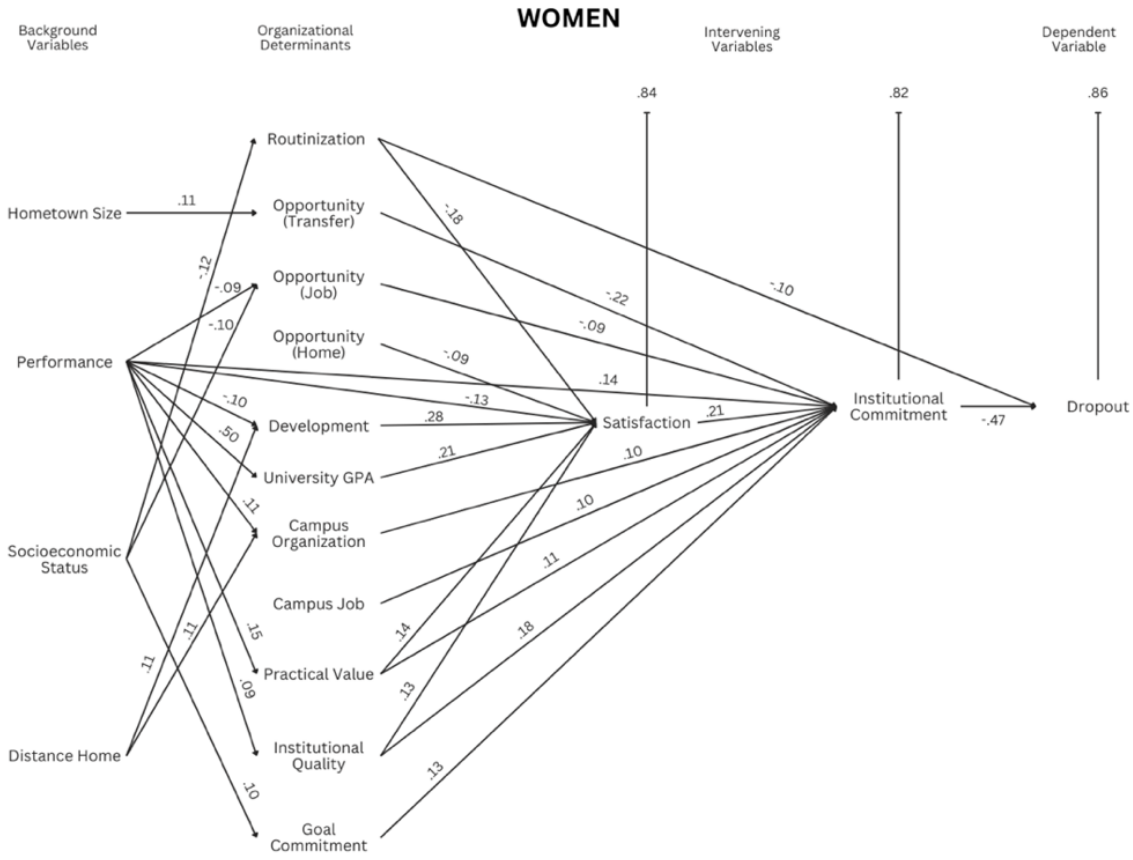

Figure 5. Bean's final Model of Student Attrition.
Adapted from Bean (1980).

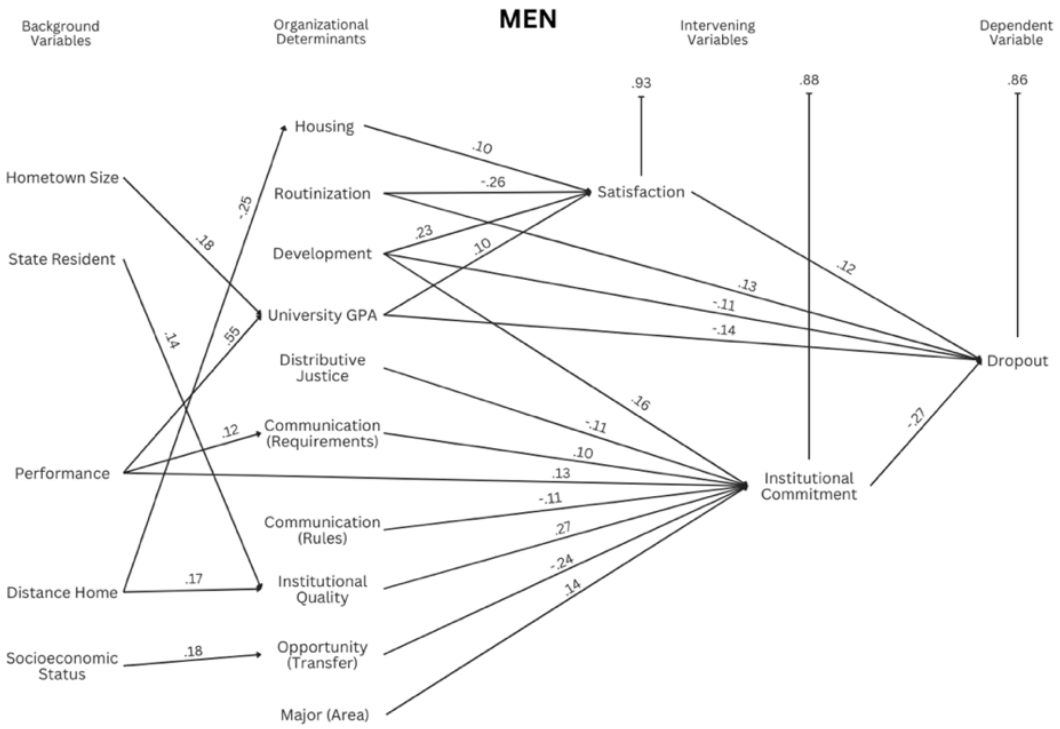

Figure 5. Bean's final Model of Student Attrition (continued).
Adapted from Bean (1980).

While theoretical modeling serves as an applicable framework for research on student attrition and retention, there are caveats to using either model. Oftentimes, these models use other theories for their basis, resulting in models that are slightly expanded versions of the other, in turn limiting their application: Spady and Tinto relied on Durkheim's Theory of Suicide, Bean relied on Price's Model of Employee Turnover. Furthermore, given the individualistic nature of student retention, not all theoretical models contain the proper elements to describe student attrition decisions. Additionally, both Spady and Tinto operate under the assumption that dropout relates to all students leaving an institution, even if that student transfers to a different institution. However, one common theme emerges from all three models: the acknowledgement that academic and social systems both have an influence on student retention.

Given the complexities of student retention, it is conceptually difficult to apply one theory when cohorts and variables differ across different institution types. While models such as

Tinto's (1975) have been tested for years, this model is longitudinal and stepwise, not truly accounting for the flexibility of retention influences. Additionally, while Spady's model (1970) implies a cyclic model, the model implies a beginning and end, which again limit the flexibility and application of the model. Perhaps a more appropriate method of mapping student retention is through systems thinking. A system consists of interrelated and interdependent components and systems thinking describes the complexity of components with purpose (18). Systems thinking has been used broadly across STEM disciplines and should be utilized to view the system holistically (19). Despite the ubiquitous use of systems thinking, there is a gap in literature with regards to retention, as systems thinking has not been applied to summarizing the interconnected influences of retention. Systems thinking allows for more perspectives and would be a more comprehensive method of characterizing retention than theoretical models. A good systems thinking model has a clearly stated purpose, includes elements to describe the system characteristics, and draws interconnections and dependencies between the elements (20). Utilizing systems thinking should begin by identifying its goal and elaborating interconnections further: simply put, defining systems thinking as a system (21).

First, it is important to identify the purpose. While most theoretical models focus on attrition as the result, a more proactive and preventative approach would better suit higher education institutions. Thus, this systems map will serve as a more comprehensive interconnection of components that influence student retention. Systems maps are designed to characterize the complexities and interconnections of elements that influence a certain outcome (18). These maps, specifically in this case, show how connected elements impact each other and have an overall downstream effect on the system outcome, positively or negatively. Perhaps, creating a system of elements that contribute to higher retention rates will serve as a guideline for

researchers to identify target areas in their own scopes. The retention systems map was created using research and literature that identified direct influences on retention, or indirect influences on retention via persistence, served as the basis for this map. Many elements were connected to retention as an outcome, and also connected with each other, which results in arrows that connect these influences together. Summarizing current literature to identify influences of retention in higher education served as the elements for this map, and additional influences can be added to this map as retention influences evolve.

Elements of Student Retention

Internal factors

Belonging, or rather a need to belong, has been regarded as a fundamental need of human motivation (22). An absence of belonging can lead to afflictive behaviors, decreased happiness, negatively impacted social, emotional, and physical health, and limited adjustment into an environment. Thus, due to the maladaptation result of belonging deprivation and benefits of social support in student persistence, it seems appropriate to regard belongingness as a required factor for student persistence. Additionally, belonging contributions to retention can be split into two metrics: academic belonging and social belonging. While academic belonging is related to a student's major and social belonging is related to institutional belonging, both have been found to be correlated to retention rates – although social belonging had a higher impact on retention (22).

Self-belief is an important constituent that may impact student retention and includes both self-efficacy and self-concept. It is important to distinguish the two, as influences on academic performance and contributing factors to retention may vary. Self-efficacy is a person's perception of their ability to act to achieve a specific outcome. This belief in one's own

competence can lead to gains in confidence, achievement, and persistence (23). Self-efficacy can be shaped by mastery experience, vicarious experience, verbal persuasion, and physiological reactions (24). Self-concept, on the other hand, is formed through environment influences, experiences, reinforcements, and frames of reference (24). It has been argued that self-efficacy is a precursor for development of self-concept, and the most critical link is the presence of perceived competence (24). Self-efficacy has been shown to help students identify a stronger sense of purpose and adopt an approach mindset, influencing problem solving, performance, goal setting and achievement, and persistence (25).

While Bean and Eaton (2002) built a psychological model of student retention in higher education, they grouped intermediate outcomes together, not distinguishing between academic and social integration and their precursors. Charalambous (2020) built on this model, identifying social interactions as a contributor to social self-efficacy and academic interactions as a contributor to academic self-efficacy (26). These each feed into social integration and academic integration, respectively. Although this model distinguishes social and academic integration, feedback loops are acknowledged between these various elements. However, most interestingly is that social self-efficacy resulted in belonging, while academic self-efficacy resulted in higher confidence, enthusiasm, work ethic, focus, and academic performance.

Academic success is influenced by prior academic achievement (including pre-university and university markers), student demographics, psychological components, student environment, and student e-learning activity, with academic achievement being the most cited and influential factor (27). Academic achievement can be linked to locus of control – a student who has an internal locus of control attributes achievement to their own abilities, thus becoming more motivated and more likely to accomplish academic success (23). Student mindset is also

important for academic success and persistence. Establishing a growth mindset leads to positive long-term outcomes, such as resiliency and academic achievement, whereas fixed mindset leads to negative long-term outcomes, such as burnout and attrition (28). It is important to note that academic success can be considered internal or external, depending on the situation in which it is viewed.

External factors

While academic success originally was thought of as full responsibility on the student, the increasing diversity and heterogenous nature of student cohorts has shifted partial responsibility on the institutions themselves. Both academic success and persistence seem to be shared between the students and the schools themselves (29). When higher education systems started to become massified, a shift towards lecture methods was implemented to meet the increasing demand, but inadvertently decreased resources and limited student-educator interactions, and subsequently decreased student engagement (30). However, there has been a push away from unidirectional classroom experiences and towards evidence-based pedagogy, which has been shown to improve academic performance and influence retention (31–34). Incorporating inclusive practices into active pedagogy improves academic performance and narrows performance gaps, especially between ethnic groups (31, 34, 35). In addition, building metacognition into the educational structure of courses can improve the retention rates of students, especially for students with larger barriers for institutional adjustment (36).

Academic experiences and environment play a crucial role in retention of students. Students are retained when good institutional support systems are in place (37). Peer mentorship opportunities can contribute to sense of belonging and better academic integration (38). Peer mentorship has been shown to increase retention rates at both the college and university level,

with the largest impact being on students who were female, first-generation, low-income, and underrepresented (39, 40). While traditional hierarchical dyad mentorship is of benefit, peer mentorship is theorized to greater contribute to student sense of belonging (40). Building learning communities has shown to improve persistence of students (41), and likely contributes to belonging in an academic setting. Additional academic supports, such as tutoring and learning assistants, can positively impact student academic success and retention (42). Finally, having clear and unique metrics of success for students contributes to academic achievement and student retention (28, 43).

Retention System

Compiling the information collected from this literature review, a system map was created to identify the complexity of influences on student retention within higher education. Figure 6 displays the interconnected elements and their influences on retention of students as highlighted and connected within the literature. Retention serves as the focus of this system because all solutions and implementations must start with the institution to initiate them. Even if a student-centric approach would be more appropriate with regards to internal elements needing to be addressed, a member of the institution would have to initiate the solution, invertedly taking an initial institutional-centric approach.

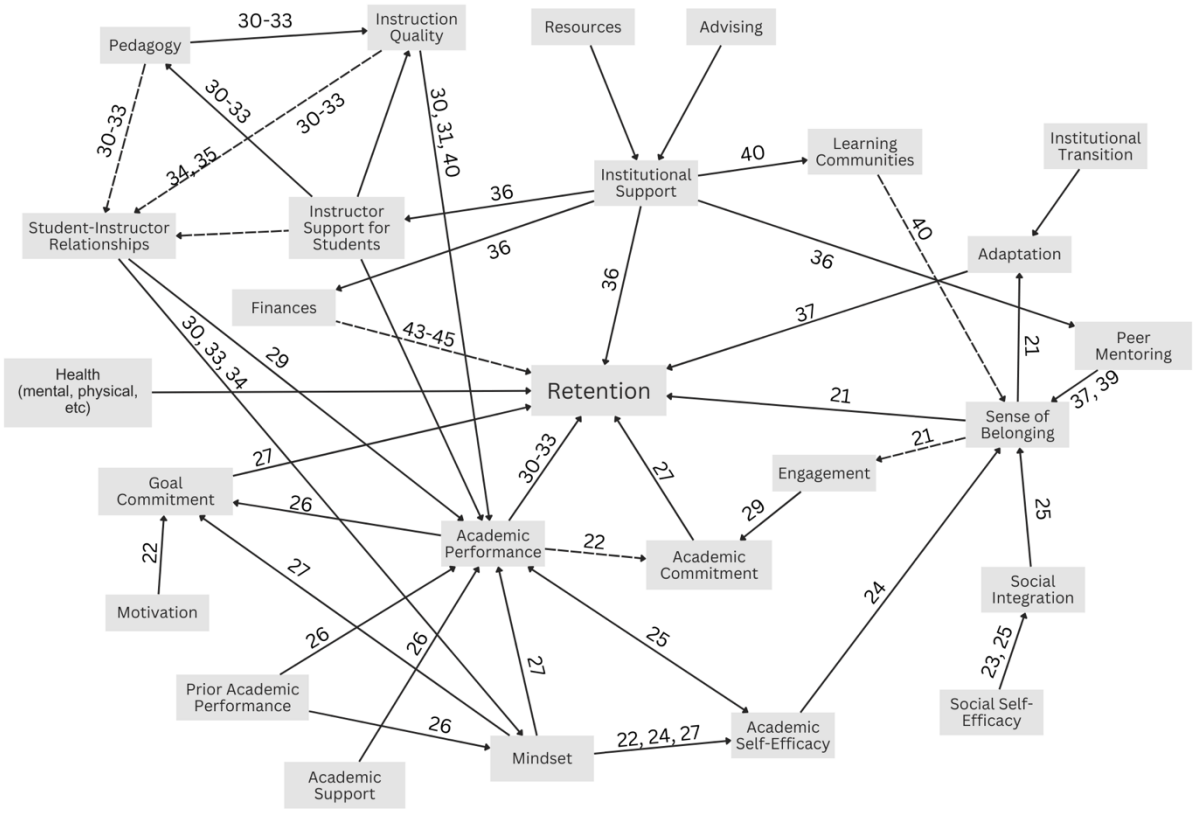

Figure 6. Systems map of retention.
Displays influences and interconnected relationships of elements impacting student retention from an institution-centric approach. Solid lines indicate a direct influence to retention or connected elements as indicated by the literature. Dashed lines indicate elements linked to persistence in literature. Numbers on lines indicate literature references.

Retention serves as the outcome of this map, and all elements included are related to the student. Some elements appear as discrete retention influences with no interconnections. Health, for instance, is shown as a discrete influence for retention. Others, such as academic performance, have many interconnections. Academic performance is influenced by academic support, mindset, prior academic performance, academic self-efficacy, student-instructor relationships, instructor support for students, and quality of instruction (29, 31, 32, 34, 36, 37). These interconnections all, in turn, affect retention via academic performance. Additional connections between these elements exist, as prior academic performance influences mindset,

and mindset can influence academic self-efficacy (23, 27, 28). Academic self-efficacy influences sense of belonging, which is also influenced by social self-efficacy and social integration, peer mentoring, and learning communities (23–26). Again, these elements influence retention via a sense of belonging outcome, which is directly related retention (22). Finally, academic elements such as pedagogy and instruction quality influence student-instructor relationships and academic performance, which in turn influence retention (31, 32, 34, 36, 41). These academic elements are influenced by institutional support via instructor support, connecting the influence the overall institution has on academic environments for retention outcomes (42). While there are many other elements, this map gives a deeper insight into the complexities of retention influences, and how they all impact each other.

It is important to acknowledge that dashed arrows indicate elements that commonly include persistence as the outcome, instead of retention. While Figure 1 displays the interconnections between persistence and retention, it seems fitting to include the less discrete connection to retention. For instance, finances (such as the cost of attendance or compensation) are oftentimes studied with regard to their influence on persistence (44–46), although indirectly influencing retention rates.

This system summarizes the influences on student retention. Perturbations of the system can cause a disbalance and influence the outcome. For influences on retention, oftentimes there is one influence that tips the scale and causes a student to leave. All elements could be present and contributing positively despite one, and that student may not be retained. An example of this would be if a student fails to establish a sense of belonging. If a student does not feel a sense of belonging, either academic or social belonging, that student is less likely to be retained. Figure 7 shows the influence of a negative sense of belonging. In this case, the student is less likely to be

engaged (negatively impacting academic commitment), and less likely to adapt, both creating a negative influence on retention of that student. While elements such as health and instructor support are untouched, the student is still at risk for not being retained. It is necessary to recognize that, while the majority of the map appears untouched, and may even have positive influences on retention, a single disbalance can result in a negative outcome, despite the majority of influences having no negative influence.

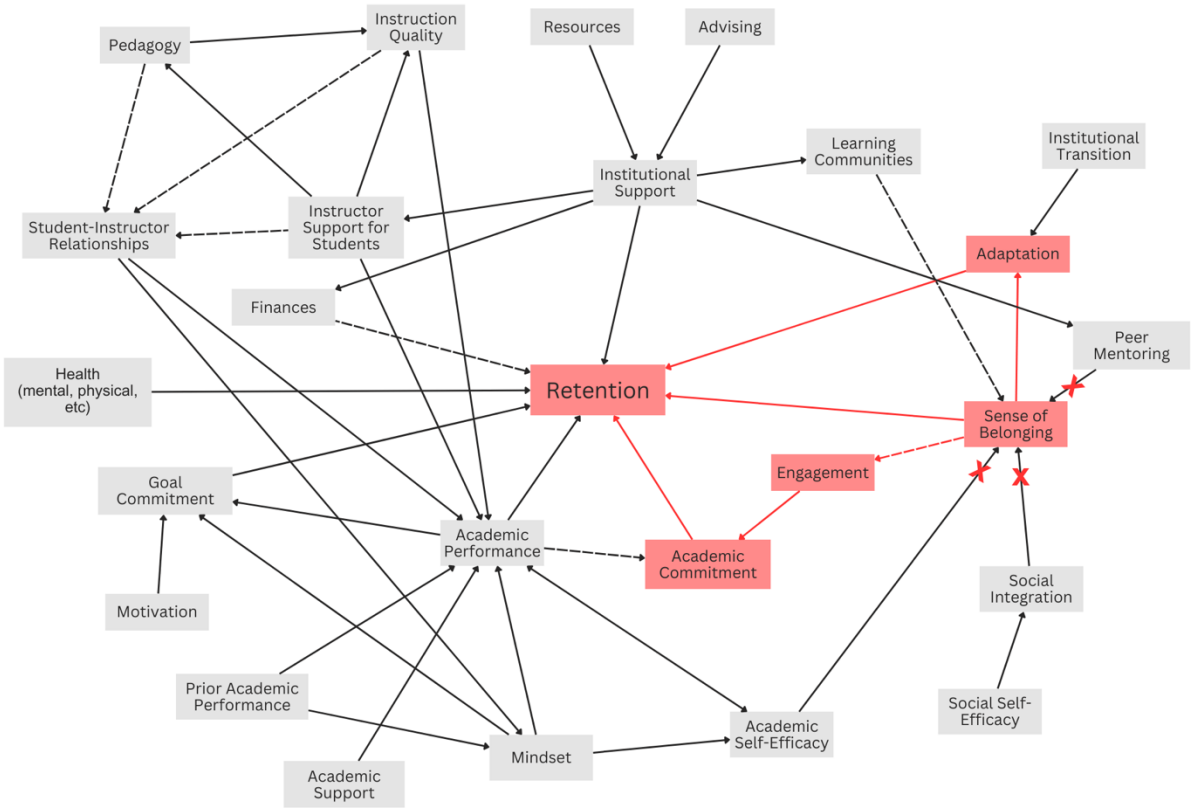

Figure 7. Perturbation in retention systems map.
Impact on retention system if sense of belonging is not established or achieved. Alternative elements would display similar patterns of influence. Solid lines indicate a direct influence to retention or connected elements. Dashed lines indicate elements linked to persistence in literature. Red lines denote a negative influence, and a red box denotes a negative outcome or element. Lines with a red "x" represent a failure to reach the desired outcome.

While the system map shown in Figure 6 provides better insight into the comprehensive effects on retention, it still does not display the full picture. This initial map only describes influences related to the student. What has not yet been considered is the impact of employees and employee support at an institution on the retention of students. John Bean (1980) hinted at this concept in his theoretical model but did not elaborate on how staff, faculty, and administrators play a key role in the student experience at a university.

Employee Influence on Student Retention

While the focus of this systems map is regarding student retention, there are elements regarding other individuals that should be accounted for with this scope. Different institutions may be organized with slight differences, and role responsibilities can vary based on policy for faculty and staff. In general, faculty tend to operate within an academic sphere, whereas staff operate more so in non-academic programs. Staff in higher education institutions can provide essential services, support administrative processes, and prepare student programming (47). Faculty typically engage students in learning within classrooms, research labs, and provide services such as advising. Both cohorts of employees are often the first interaction with new students at university and those connections are sustained through their enrollment.

Faculty who engage with students in the classroom can impact student retention: content knowledge and mastery, teaching style, empathy, enthusiasm, feedback provided, course expectations, and support are all shown to influence student retention (48). Academic advising, which can be provided by faculty or staff, plays a crucial role in students' retention and persistence to graduation (49). Faculty approachability, such as being accessible at times when students need, plays a role in student success (50). Student-faculty values congruence can contribute to academic fit and is positively associated with performance and persistence (51). For

students, faculty are not perceived solely as instructors; they are seen as individuals who can help students in their development and goal achievement (52).

Given their contribution to student success, satisfaction, and support, and their influence on student retention, employee turnover can cause greater negative impacts that span deeper than work organization stress. Employee engagement and career development have been shown to positively correlate with performance and employee retention (53). A harmonious work-life balance can contribute to employee success and decision to stay in the work organization (53, 54). Current management, leadership style, and work environment are essential factors in employee retention, and training, development, and supportive resources are important for establishing satisfaction, belonging, and job retention (54). Research has shown a that prioritizing employee development and empathetic leadership fosters a positive climate, resulting in more proactive employees that better contribute to the student experience (54, 55). Overall, faculty job satisfaction is a significant contributor of both employee and student retention (56, 57), which highlights the importance of focusing not only on student retention, but employee retention as well.

A further revised systems map that elaborates on the influences of institution employees would better display the true complexity of student retention. Figure 8 shows the revised Retention Systems Map (adapted from Figure 6) to include these additional important elements. This revised map displays the interconnections that employees have on student retention, and further stress the importance of employee retention on student experience.

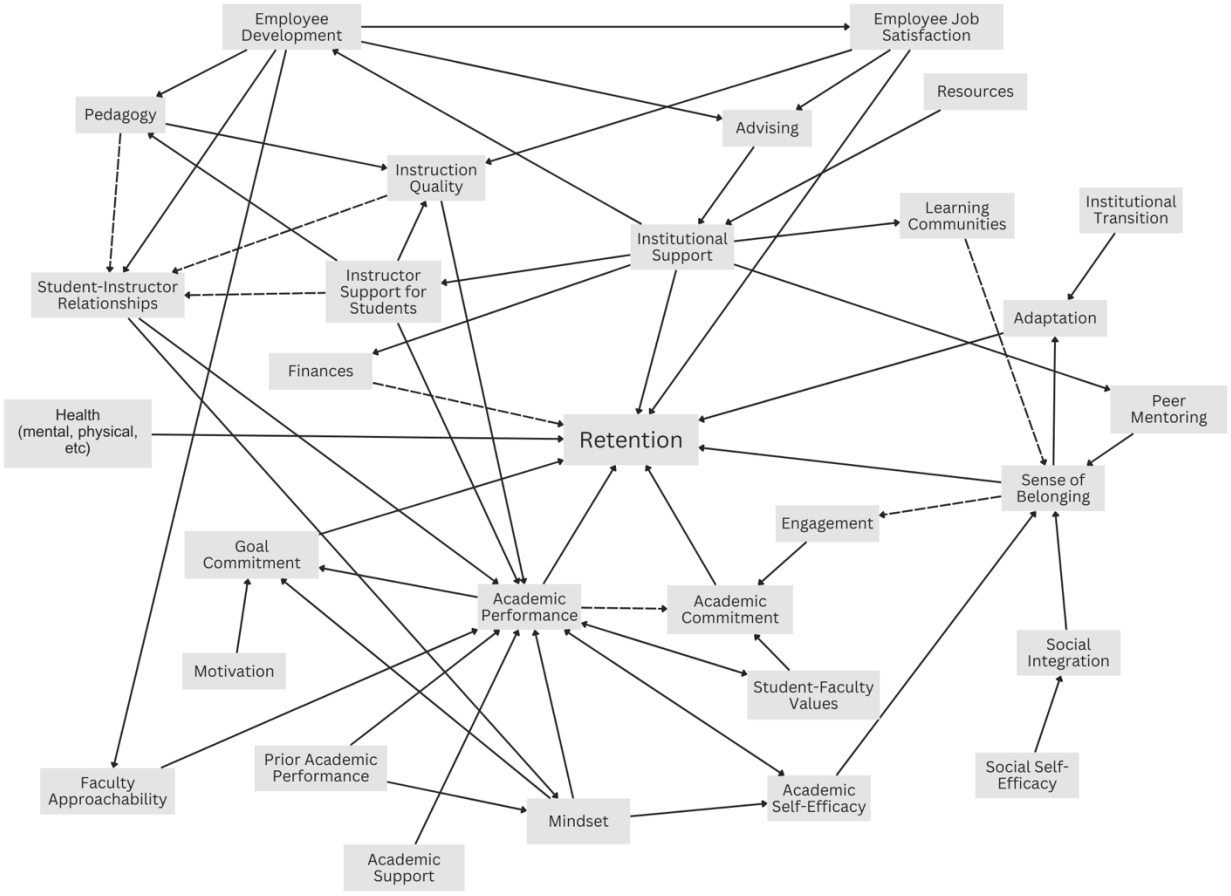

Figure 8. Revised student retention systems map.
Includes influence of institution employees on retention of students. Solid lines indicate a direct influence to retention or connected elements. Dashed lines indicate elements linked to persistence in literature.

Elements such as employee development, employee job satisfaction, and faculty approachability are added. Employee development influences pedagogy, student-instructor relationships, advising, and job satisfaction, and is influenced by instructional support. Additionally, employee development can influence faculty approachability, which impacts academic performance and student retention. Employee job satisfaction directly influences instruction quality, advising, and retention of students. While retention practices often take a student-centric approach, it is imperative to consider the influence that institution employees have on student retention. Due to the elaborations, this revised map is the most comprehensive

view of influences on student retention and should be utilized by higher education institutions to identify perturbations and implement solutions to prevent negative outcomes.

Similarly to discussed in Figure 6, systems maps can be used to describe the trickle-down effect of a perturbation. With the further elaborated and revised systems map, there can be harmful effects on student retention if employee retention is not prioritized. For example, if employee development is not prioritized by the institution, Figure 9 shows the effect downstream: student-instructor relationships, instructor support, instruction quality, and student performance are all negatively impacted. Along with other elements denoted by a red box, this has a downstream negative effect on student retention.

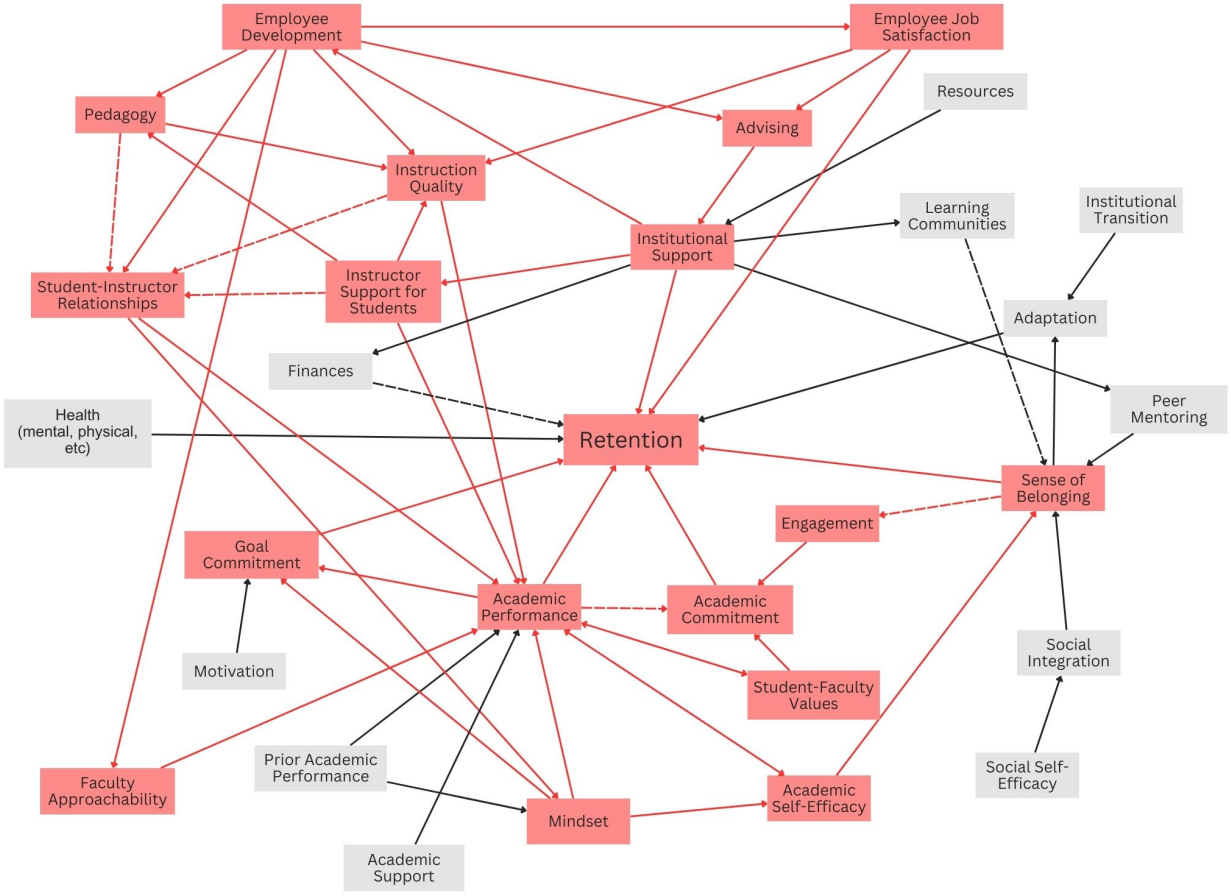

Figure 9. Perturbations of employee retention on student retention.
Example of downstream effect if employee development is not available or sufficient. Solid lines indicate a direct influence to retention or connected elements. Dashed lines indicate elements linked to persistence in literature. Red lines denote a negative influence, and a red box denotes a negative outcome or element.

While student retention is often viewed with the sole focus of an institution on the student, failing to account for employee influence will be detrimental. Figure 9 displays this well, as one negative impact on employees (poor employee development) can influence ten other elements that are almost all student facing. It is important to reiterate that, while all other elements may be positive, a negative retention outcome can be a result of just one negative element in the map. Thus, while institutions should focus on student-centric solutions, institutions must also prioritize employees and their experience in their roles.

Conclusion

The systems map displayed is comprised of co-implying elements. This can be used as a framework to dive deeper into the complexities of student retention and individualistic nature of attrition decisions. It is important to note that perspective changes the function of the system (58), and thus future applications must state intended perspective prior to application. Retention initiatives become more successful when interventions acknowledge the broad diversity in motives of students leaving an institution instead of strategizing to prevent attrition as a whole (59) Focusing initiatives on students who are transferring rather than dropping out of higher education entirely may be more fruitful in terms of retaining students (59). In addition to using a student-centered approach, it is important for institutions to prioritize employee well-being, as that plays a major role in workplace climate and student retention.

Despite the ubiquitous research on retention impacts and strategies, retention is deeply complex with numerous interconnected influences on each other and on the system as a whole (48, 60). This makes implementing retention solutions complicated, intricate, and individualized for the student at hand. Utilizing the systems map allows for future researchers to compare data of student attrition and focus on one of the given elements for retention-focused solutions in a given scenario. What may be most important to acknowledge is that retention-focused solutions do not have a “one size fits all” approach. Interventions are highly variable and individualistic, and utilizing a systems map may be the best approach to achieving the most effective outcome.

CHAPTER 2: UTILIZING A VIRTUAL COMMUNITY MODEL TO PROMOTE PERSISTENCE OF STUDENTS INTO THE STEM WORKFORCE

Introduction

Workforce development and preparation for careers in Science, Technology, Engineering, and Math (STEM) is vital to both individual success and maintaining the US economy. While STEM employment only made up a small fraction of the national employment, there are some industries where STEM jobs account for over half the workforce, and these job markets are on the rise (4). In fact, North Dakota has been ranked among the highest states with STEM employment rate growth, taking first in 2017 with 26%, over twice the national average at the time (4).

Over the last decade, workforce needs for individuals with experience or expertise in STEM has grown over 33%, and STEM has a historical discrepancy in gender and racial employment – most notably, underrepresentation of African Americans, Hispanics, and women (1). While these gaps are starting to lessen (1), it is clear that these disparities are still prevalent in many fields, and can vary significantly by discipline. For instance, women are overrepresented in health-related disciplines but heavily underrepresented in engineering and computer science disciplines (61). With the most recent employment projections in STEM occupations expecting to rise over 10% by the year 2032 (2), preparation for these needs – and persistence of students in STEM – is vital.

According to the United States Census Bureau, less than 30% of workers who hold a STEM bachelor's degree work in STEM fields, as the vast majority are choosing non-STEM careers (5). Of students who did not earn a degree in STEM, 9.6% chose careers in STEM or STEM-related fields (5). Figure 10 shows the STEM workforce pathway, and while this depicts

undergraduate degrees only, it is important to note that this is only part of the picture. Individuals with only a bachelor's degree make up about 60% of the college-graduated STEM workforce, whereas individuals with a graduate degree (masters, doctoral, etc.) make up the remaining 40% (5). However, not all STEM workforce jobs require a bachelor's degree. In fact, only about 45% of the general STEM workforce is made up of individuals with a 4-year degree or more (7). When analyzed for just science and engineering jobs, that proportion jumps to 76.5%, with the remaining workforce fulfillment has partial college education or an associate's degree (7). While it is important to retain students in STEM disciplines through graduation, it is also vital for encouraging persistence of students into the STEM workforce.

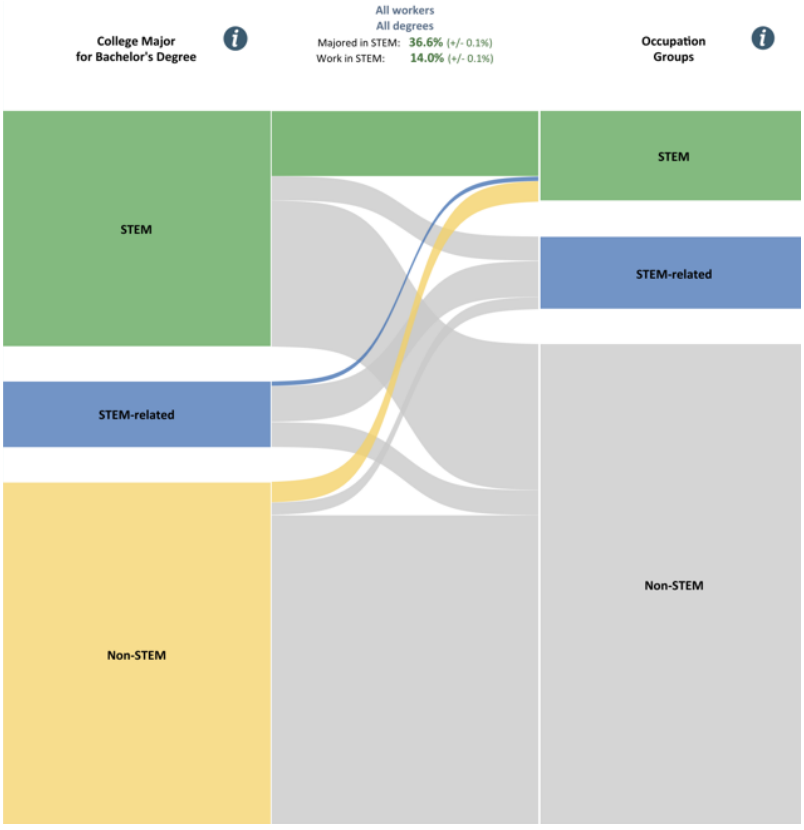

Figure 10. Undergraduate student pathway in STEM.
Source: United States Census Bureau.

To encourage student persistence into the STEM workforce, it is important to promote student success and academic persistence. There are several influences that impact a student's success and persistence in their degree paths, including those of STEM (32). Near-peer mentoring has shown to have positive effect on their persistence in STEM, academic success, sense of belonging, and role modeling (62, 63). Professional development opportunities, specifically for students, has been shown to help students develop their skillset and be more competitive employees in the workforce (64). With persistence in science in mind, journal clubs have been shown to increase abilities in scientific communication and scientific methodology applications (65, 66). Self-efficacy is an important concept in persistence of students, influencing problem solving and academic achievement (25). While any of these elements on their own can have a positive effect, creating an opportunity for students to engage in all of these elements may have the most positive influence. Perhaps creating a program that allows for the combination of these approaches would maximize the development of students enrolled, and their STEM workforce persistence.

The National Science Foundation (NSF) awarded North Dakota Established Program to Stimulate Competitive Research (ND EPSCoR) a Track-I research infrastructure cooperative agreement titled New Discoveries in the Advanced Interface of Computation, Engineering and Science (ND-ACES) to strengthen the North Dakota STEM ecosystem. The Education and Workforce development arm of ND-ACES was charged with supporting a diverse pool of competitive researchers, skilled workers, effective educators, and engaged students. One activity towards this initiative is the development of Research Training Groups (RTG) for undergraduate and graduate students involved with the ND-ACES project. The cooperative agreement began in 2020, and the RTG program was launched shortly after. The intention of the RTG is to facilitate

a vertically integrated support system aimed at helping retain undergraduate and graduate students and promote their success as future STEM researchers. A multipronged approach, including professional development sessions, monthly support newsletters, annual conference gatherings, monthly journal clubs, and multidisciplinary mentoring networks, was designed to support student success. Undergraduate students are set up to be mentored toward STEM careers or graduate school, and graduate students to be mentored towards careers in research, industry, or academia. These opportunities were designed to help build students' skills in areas such as teamwork, communication, and presentation skills through student idea exchanges.

In addition to the RTGs, ND-ACES included a Distributed Research Experience for Undergraduates (dREU). This was a program designed for undergraduate student researchers to partake in a research project under a different research supervisor at another institution for the summer and then continue the research at their home institution facilitated by collaboration between faculty at both institutions. Initially, the dREU program was kept separate from the RTGs, with separate professional development incorporated into the dREU experience. Beginning spring Y3 of the cooperative agreement, the dREU program was incorporated into the RTGs, allowing dREU students the opportunity to participate in the same components (professional development, journal clubs, conference gatherings, and mentoring) of the RTGs.

The aim of this study was to implement a program designed to support student success and allow for students on a Track-1 to connect and strengthen their professional development. Students enrolled in the RTG and dREU program spanned ten institutions across the state of North Dakota. This unique feature allowed students to connect, mentor, and learn from students at different institutions with vast areas of focus in their degree paths. Due to this, the majority of the interactions for these programs were virtual. The RTG and dREU programs serve as

opportunities for students to network, mentor, develop their skill set, and ultimately influence research success and persistence in STEM disciplines.

Methods

Study design

The purpose of this study was to measure the effectiveness of the RTG to build students' confidence, sense of belonging, and persistence in the STEM field. This program was designed for students to gain skills and knowledge through engagement with others in professional development or peer mentorship. The element of peer mentorship specific to the RTG program is between program participants. Current RTG participants are likely to engage in peer mentorship in their own laboratory setting, and the peer mentorship of RTG students is designed to be in conjunction to their current research community. Figure 11 displays the four key metrics utilized in the surveys: professional/technical skills, self-efficacy, sense of belonging, and persistence/intentions were the primary indicators for success of the RTG.

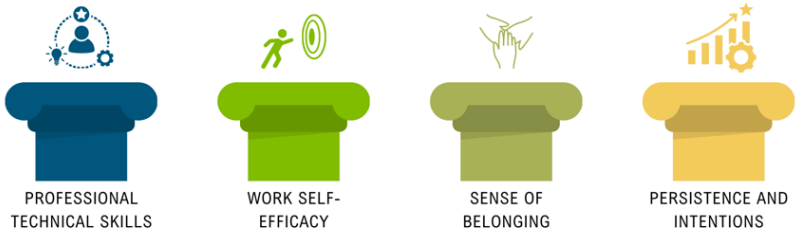

Figure 11. Key metrics analyzed for RTG program.
Metrics include professional technical skills, work self-efficacy (measured on two scales), sense of belonging, and persistence and intentions in STEM.

This program consisted of student-led peer-mentor groups, a monthly student-led journal club, a monthly faculty-led professional development opportunity, a monthly newsletter, and any resources related to academic or professional success. Additionally, there was an annual conference gathering hosted at a North Dakota institution with networking events for both ND-ACES and RTG participants. All implementations were conducted virtually via Microsoft

Teams. This virtual environment had channels designated for providing information, sharing resources, and individualized mentorship hubs where mentor groups could meet. All implementations were designed around four key metrics, which were used to analyze the effectiveness of the interventions.

Ethical approval

This research study was approved by the Institutional Review Board. Initially at University of North Dakota under UND IRB0004639 before a change in leadership resulted in NDSU personnel continuing the project under NDSU IRB0004778. The dREU program is listed under NDSU IRB0003748.

Subject participants

RTG

All graduate and undergraduate research students participating under the EPSCoR ND-ACES were automatically enrolled in the RTG program. Participation in RTG programing was expected but voluntary. All students received access to these interventions and communications requesting to complete the surveys, regardless of if they had participated in RTG programing or not. Attendance was taken at all RTG programming events. The students on ND-ACES were spread across the state of North Dakota, at ten institutions, and thus this program was administered virtually, with an exception of the annual conference poster session and networking event.

dREU

All participants for the dREU program were invited to apply by home institution faculty and then selected for the program. The student's home institution faculty member coordinated with a faculty member at a research institution, where the student would be assigned for the

summer months, before returning to their home institution for the remaining months of the dREU experience. The program lasted for a full academic year. Selected participants received a summer housing stipend and salary for their research time, any associated tasks, and involvement in program components (such as professional development). Requirements of the dREU commitment include presenting a poster of their work at the annual ND EPSCoR Conference.

Data collection

Persistence of STEM data was collected for both RTG and dREU participants. Social media networking platforms, such as LinkedIn, were utilized to see current workforce fields and positions of all previous students enrolled in ND-ACES. This data was used to determine whether RTG or dREU participants stayed in STEM disciplines or chose non-STEM pathways.

RTG

Students were asked a series of survey questions to self-reflect based on four key metrics. Data was collected through digital surveys administered through Qualtrics (Appendix A). All students took the baseline survey at the start of their commitment to the program. Additional follow-up surveys were administered at the end of each academic year (AY) of the program. Individual students were coded with a unique ID number to track their length of participation. Survey questions were all Likert scaled, except for questions regarding participation and demographics which were multiple choice. All surveys were administered via Qualtrics.

dREU

The dREU students were administered two surveys, one prior to their dREU experience and one following. The survey included key metrics, such as: oral communication, understanding others' research, discussing own research with others, teamwork skills, written communication,

and ethical research ability. The survey was two-tiered and included multiple-choice, fill-in-the-blank, and scaled-response questions, and surveys were administered virtually via Qualtrics.

RTG program components

All RTG program components were hosted and distributed in a virtual centralized communication platform as participants were in different areas across the state. This communication platform was utilized to mitigate communication barriers and add to ease of use, as well as provide more efficient modes of communication, connection, and networking. Mentor groups were designed initially as a hierarchical style of mentorship. Senior graduate students mentored junior graduate students who mentored undergraduates. These mentorships were among students within the same discipline. After Y2 of the RTGs, the mentor groups were redesigned to be more encompassing of peer mentorship. Students were randomly assigned a mentor group with students from multiple disciplines. Each group was given their own channel on Microsoft Teams to connect and host their scheduled mentor meetings, as well as resources on effective mentorship.

A monthly student-led journal club was available and open for students to volunteer to lead. Students volunteered in advance, chose a scientific research paper related to their discipline or a paper they were currently writing, shared with the RTG participants, and led the discussion.

Beginning in February of 2022, monthly faculty-led professional development (PD) opportunities were introduced as a program component. All PD sessions were held virtually, recorded, and stored virtually in Microsoft Teams to be accessed at any time by RTG participants. In order of occurrence, the following are the hosted PD sessions: open session to identify most sought after professional development sessions, stress prevention and effective time management, creating and utilizing an individual development plan (IDP), building a

CV/resume and online professional presence (such as with LinkedIn), how each student fits into the EPSCoR Track-1 and additional preparation for the NSF site visit, how to apply to graduate or professional school. PD sessions implemented after data collection were centered around science communication (posters and short talks) and CIMER Entering Mentoring curriculum in the fall and spring semesters of Y4, respectively. Figure 12 displays the general timeline of the RTG program implementation and adaptations.

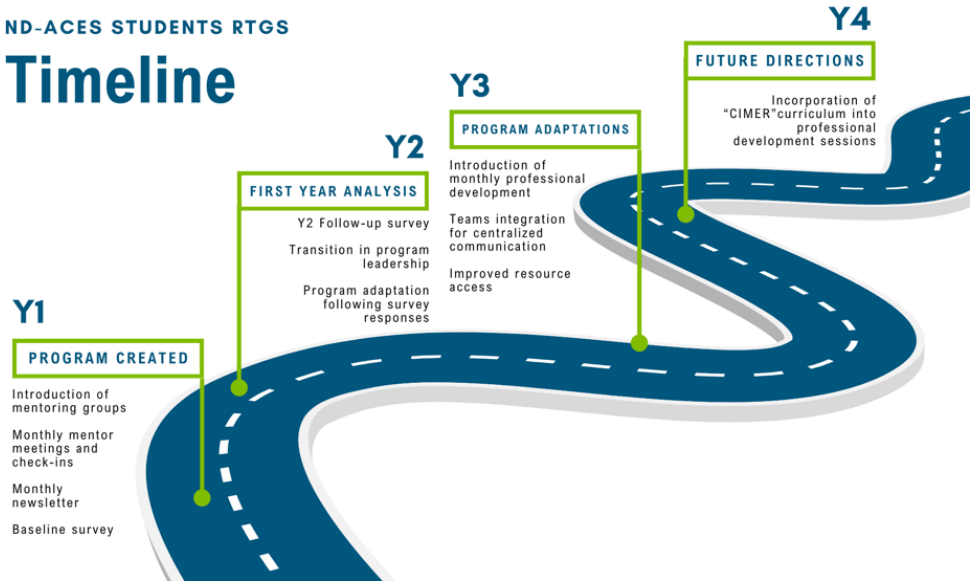

Figure 12. RTG Program timeline.
Y1 corresponds to AY 2020-2021, Y2 to AY 21-22, Y3 to AY 22-23, and Y4 to AY 23-24. Current research is being collected for Y4 and will be reflected in a Y4 follow-up survey.

Statistical analysis

Data analysis began for RTG data by compiling responses of participants for each follow-up survey, aggregating the data for analysis, and comparing that output to the baseline survey. In addition, due to student turnover on the grant, individual IDs were separated based on length in the program and compared to their own baselines. Additionally, data on the participants' research productivity was collected from subject self-reporting and collection from their primary investigator's reports. This data was identified as "number of presentations and publications" and

was identified as a count without connection to the student's name. Quantitative data was averaged for individual responses (for example, ID 1 responded 4, 5, 4 for PTSkills, therefore had an average 4.3 in PTSkills). All quantitative data was analyzed in R.

Due to the voluntary nature of the RTG program, self-reported data was collected on involvement with similar programs within their own institution, as well as each area of the RTGs. Data was also collected on the personnel end with actual documented RTG participation.

The dREU program had a corresponding pre- and post-survey related to their research experience. Data collected was over multiple years, and each dREU student was unique. Participation in the RTG components were voluntary, but there were required components to their program as set by each individual research advisor. All quantitative data was analyzed in R. Qualitative responses in the post-survey were coded using deductive thematic analysis (67).

A power analysis was run to determine what sample size value is appropriate to determine any significance. Using a small effect size (0.2) and a p-value of 0.05, the power analysis showed that the sample size needed to determine significance was much larger than collected. Thus, no statistical analysis was run for either the dREU or the RTG datasets.

RTG demographics

Table 1 displays the collected demographic information of RTG participants broken by the survey taken (baseline, Y2, or Y3). Demographic survey information (Table 1) collected did not require a response, and some students opted not to answer specific prompts. Additionally, for questions about race, multiple choice selection was allowed. While dREU surveys also collected demographic information, the sample size was not large enough to ensure anonymity with displaying the results – therefore, it is not included.

Table 1. Demographics of study participants.

		Baseline (N=43)		Y2 (N=24)		Y3 (N=20)	
		Freq.	%	Freq.	%	Freq.	%
Student	Undergraduate	20	46.5	8	33.3	3	15.0
	Graduate	23	53.5	26	66.7	17	85.0
Sex assigned at birth	Male	24	55.8	11	47.8	10	50.0
	Female	19	44.2	12	52.5	10	50.0
Gender identity	Man	25	58.1	11	45.8	9	45.0
	Woman	18	41.9	13	54.2	10	50.0
Hispanic/Latinx	Yes	2	4.7	-	-	1	5.0
	No	41	95.3	24	100	19	95.0
Race	American Indian, Alaska Native, Native American, or Indigenous	-	-	-	-	1	5.0
	Asian	16	37.2	13	54.2	10	50.0
	Black or African American	-	-	-	-	2	10.0
	Middle Eastern or North African	1	2.3	1	4.2	1	5.0
	White	25	58.1	24	41.7	7	35.0
Sexual Orientation	Asexual	3	7.0	2	10.0	1	5.0
	Bisexual	2	4.7	1	5.0	1	5.0
	Demisexual	1	2.3	-	-	1	5.0
	Heterosexual	26	60.5	16	80.0	14	70.0
	Pansexual	1	2.3	-	-	-	-
	Questioning	1	2.3	-	-	-	-
	Other	-	-	1	5.0	-	-
Relationship status	Single	25	58.1	11	45.8	9	45.0
	Married	14	32.6	11	45.8	11	55.0
	Divorced	1	2.3	-	-	-	-
	Other	1	2.3	-	-	-	-
Minority/Underrepresented in STEM	Yes	9	20.9	10	45.5	12	60.0
	No	31	72.1	21	54.5	7	35.0
International Student	Yes	20	46.5	15	62.5	14	70.0
	No	23	53.5	9	37.5	6	30.0
Highest Degree Earned	High school diploma	17	39.5	6	25.0	2	10.0
	Associates degree	3	7.0	2	8.3	1	5.0
	Bachelors degree	5	11.6	5	20.8	6	30.0
	Masters degree	16	37.2	11	45.8	8	40.0
	Doctoral degree	2	4.7	-	-	2	10.0

Results

RTG program

Not all RTG participants responded to the survey, so results are descriptive of all survey respondents. Baseline respondents are those who took the initial survey. Y2 and Y3 are respondents who took the follow-up survey in June of 2022 and 2023, respectively.

Table 2. Aggregated descriptive statistics of key metric outcomes of RTGs.

Baseline						
Key Metric Outcomes	Professional Technical Skills	Work Self-efficacy (Scale 1)	Work Self-efficacy (Scale 2)	Sense of Belonging	Persistence & Intentions (Graduate)	Persistence & Intentions (Undergraduate)
N	43	43	43	43	23	20
Mean	3.76	4.58	4.56	6.023	4.17	3.45
Std. Dev.	.69	.39	.41	.87	.97	1.12
Y2						
Key Metric Outcomes	Professional Technical Skills	Work Self-efficacy (Scale 1)	Work Self-efficacy (Scale 2)	Sense of Belonging	Persistence & Intentions (Graduate)	Persistence & Intentions (Undergraduate)
N	24	24	24	23	20	8
Mean	3.91	4.68	4.54	6.14	4.30	3.88
Std. Dev.	.90	.80	.52	.90	.865	.963
Y3						
Key Metric Outcomes	Professional Technical Skills	Work Self-efficacy (Scale 1)	Work Self-efficacy (Scale 2)	Sense of Belonging	Persistence & Intentions (Graduate)	Persistence & Intentions (Undergraduate)
N	20	20	20	20	17	3
Mean	4.22	4.81	4.63	6.21	4.53	4.25
Std. Dev.	.92	1.14	.57	1.07	.87	.62

Student level is combined, although persistence and intentions is split by cohort.

Table 2 details the descriptive statistics for aggregate survey respondents and cohorts. Although statistical analysis was not run, trends were seen in the datasets. Survey respondents reported increased self-analysis with relation to all five key metrics observed in Y3 compared to baseline. Similar trends were seen from baseline to Y2, although not universal (work self-

efficacy saw a slight decrease in Y2), and not as drastic as the Y3 to baseline comparisons. After observing this data, it was determined to split by cohort to observe the differences occurring for graduate vs undergraduate students.

Table 3. Cohort key metric outcomes of RTG.

Baseline						
Key Metric Outcomes	Undergraduate			Graduate		
	n	M	SD	n	M	SD
Professional Technical Skills	20	3.60	.885	23	3.89	.437
Work Self-efficacy (Scale 1)		4.30	1.11		4.83	.576
Work Self-efficacy (Scale 2)		4.45	.445		4.57	.377
Sense of Belonging		6.15	.593		5.91	1.06
Y2						
Key Metric Outcomes	Undergraduate			Graduate		
	n	M	SD	n	M	SD
Professional Technical Skills	8	4.10	.687	15	3.82	.647
Work Self-efficacy (Scale 1)		4.63	1.10		4.71	.653
Work Self-efficacy (Scale 2)		4.74	.302		4.45	.585
Sense of Belonging		6.28	.749		6.07	.984
Y3						
Key Metric Outcomes	Undergraduate			Graduate		
	n	M	SD	n	M	SD
Professional Technical Skills	3	3.41	1.22	17	4.36	.779
Work Self-efficacy (Scale 1)		4.24	1.24		4.90	1.10
Work Self-efficacy (Scale 2)		4.30	.596		4.69	.548
Sense of Belonging		5.33	1.37		6.37	.928

Split by graduate and undergraduate student groups and reported across survey taken. Note that the n changes as enrollment in the program was fluid.

After splitting by cohort, the trends observed are not the same as those that are aggregated (Table 3). While our sample size decreased over time, our undergraduate population became increasingly less active in the RTG program survey, despite enrollment remaining

consistent. The persistence and intentions metric was not included in this table as it is split by cohort in Table 2. Table 3 shows that our graduate student cohort reported higher self-analysis for the above three key metrics in Y3 compared to Y2 and to the baseline. Undergraduate students, however, did not report the same. Undergraduate students reported lower confidence in professional technical skills, work self-efficacy, and sense of belonging in Y3 compared to both Y2 and baseline.

One important feature to note about the RTG program is that enrollment was fluid and participation was not required. Because of this enrollment fluidity, the students taking the Y3 survey were not always the same students who had taken the Y2 survey, and many of them had not taken a baseline. Additionally, membership in this program ended when students left the project, which also was on a rolling basis. The date a student left the project did not always correspond with yearly data collection. Finally, acknowledging that not all students have the same perception of what the Likert values mean (a 5 for one person may be a 4 for another), aggregate data was determined to not be the best picture of the program effect. Due to the varying length in the program and differences in surveys taken, a more normalized method of reporting data was considered, since aggregate data was not the most accurate way of analyzing the effects of the program.

Any initial survey response (whether it was baseline, Y2, or Y3) for a unique student ID was normalized and reported as “year 1 in the program”. Subsequent survey responses were then included as their “year 2” and “year 3” when applicable. Each individual response was mapped with a line to observe their own personal trends. Any singular data point is a student with only one response. Data points were color-coded to represent the academic year they began in the RTG program, and shape of data point depicts undergraduate or graduate cohort.

A

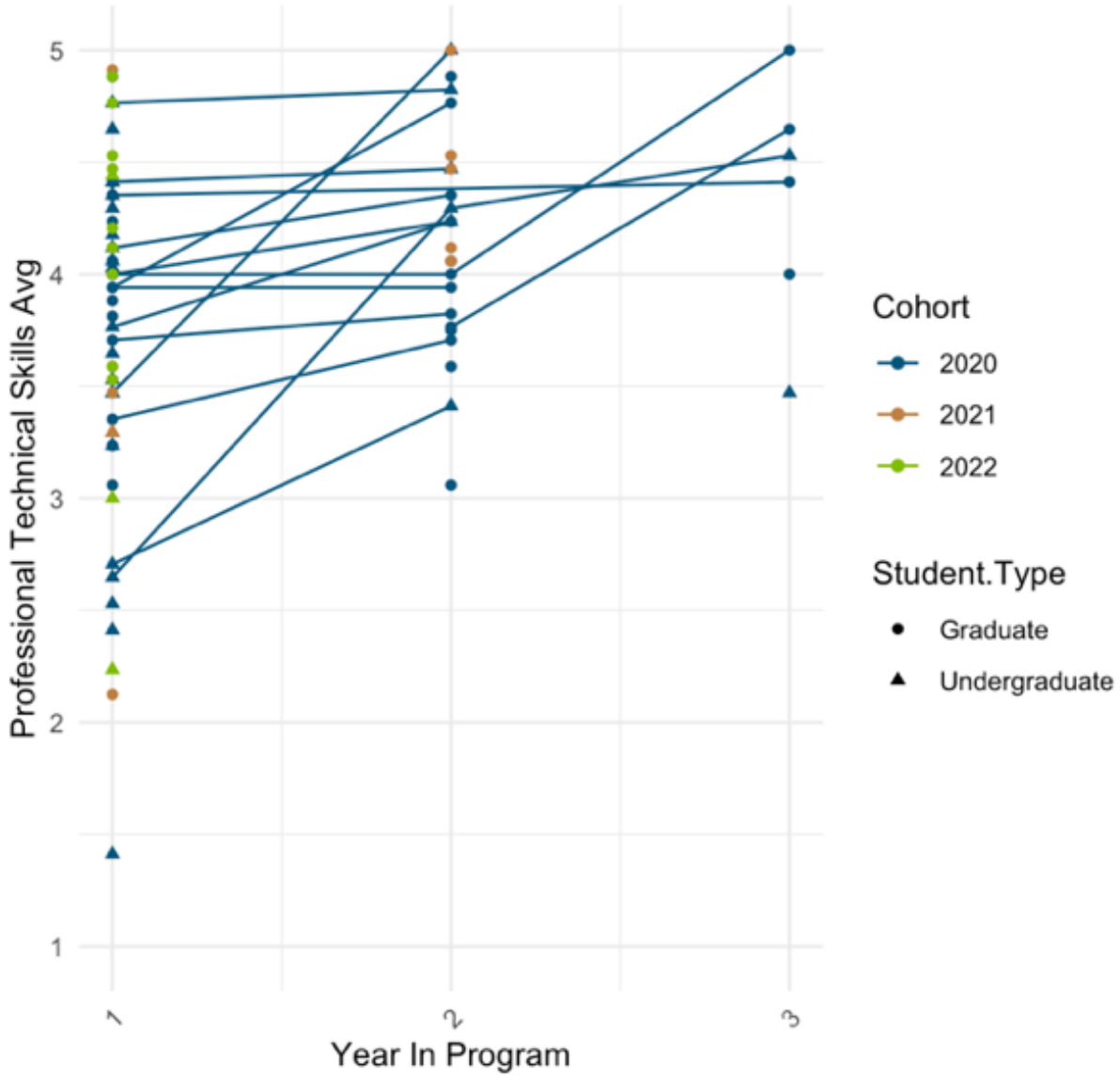

Figure 13. Key metric analysis across individual student IDs length in the program. Graduate and undergraduate levels are distinguished, and graduate student levels include most Master and Doctoral students. Enrollment in the program is distinguished based on the date the student joined the grant. Cohort 2020 are all students who started during AY 2020-2021, cohort 2021 are all students who started during AY 2021-2022, and cohort 2022 are all students who started during AY 2022-2023. Cohort 2023 data will be collected at the end of the 2023-2024 Academic Year. Year in program represents which survey has been taken (1=Baseline, 2=Y2, 3=Y3). A. Survey respondents' responses to items related to Professional Technical Skills (scale 1-5). B. Survey respondents' responses to items related to Self-Efficacy (scale 1-6). C. Survey respondents' responses to items related to Sense of Belonging (scale 1-5). D. Survey respondents' responses to items related to Self-Efficacy (scale 1-5). E. Survey respondents' responses to items related to Persistence and Intentions (1-5).

B

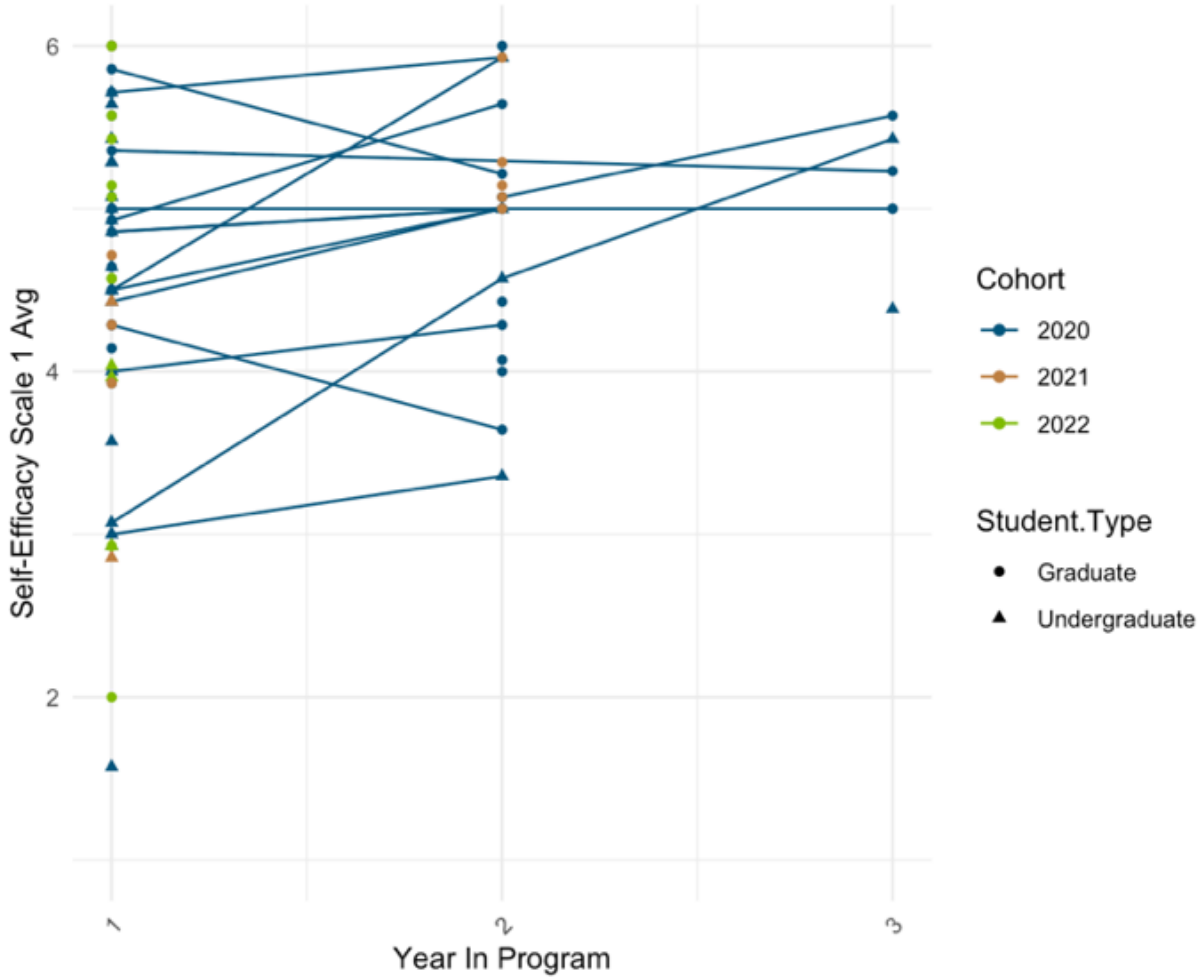

Figure 13. Key metric analysis across individual student IDs length in the program (continued). Graduate and undergraduate levels are distinguished, and graduate student levels include most Master and Doctoral students. Enrollment in the program is distinguished based on the date the student joined the grant. Cohort 2020 are all students who started during AY 2020-2021, cohort 2021 are all students who started during AY 2021-2022, and cohort 2022 are all students who started during AY 2022-2023. Cohort 2023 data will be collected at the end of the 2023-2024 Academic Year. Year in program represents which survey has been taken (1=Baseline, 2=Y2, 3=Y3). A. Survey respondents' responses to items related to Professional Technical Skills (scale 1-5). B. Survey respondents' responses to items related to Self-Efficacy (scale 1-6). C. Survey respondents' responses to items related to Sense of Belonging (scale 1-5). D. Survey respondents' responses to items related to Self-Efficacy (scale 1-5). E. Survey respondents' responses to items related to Persistence and Intentions (1-5).

C

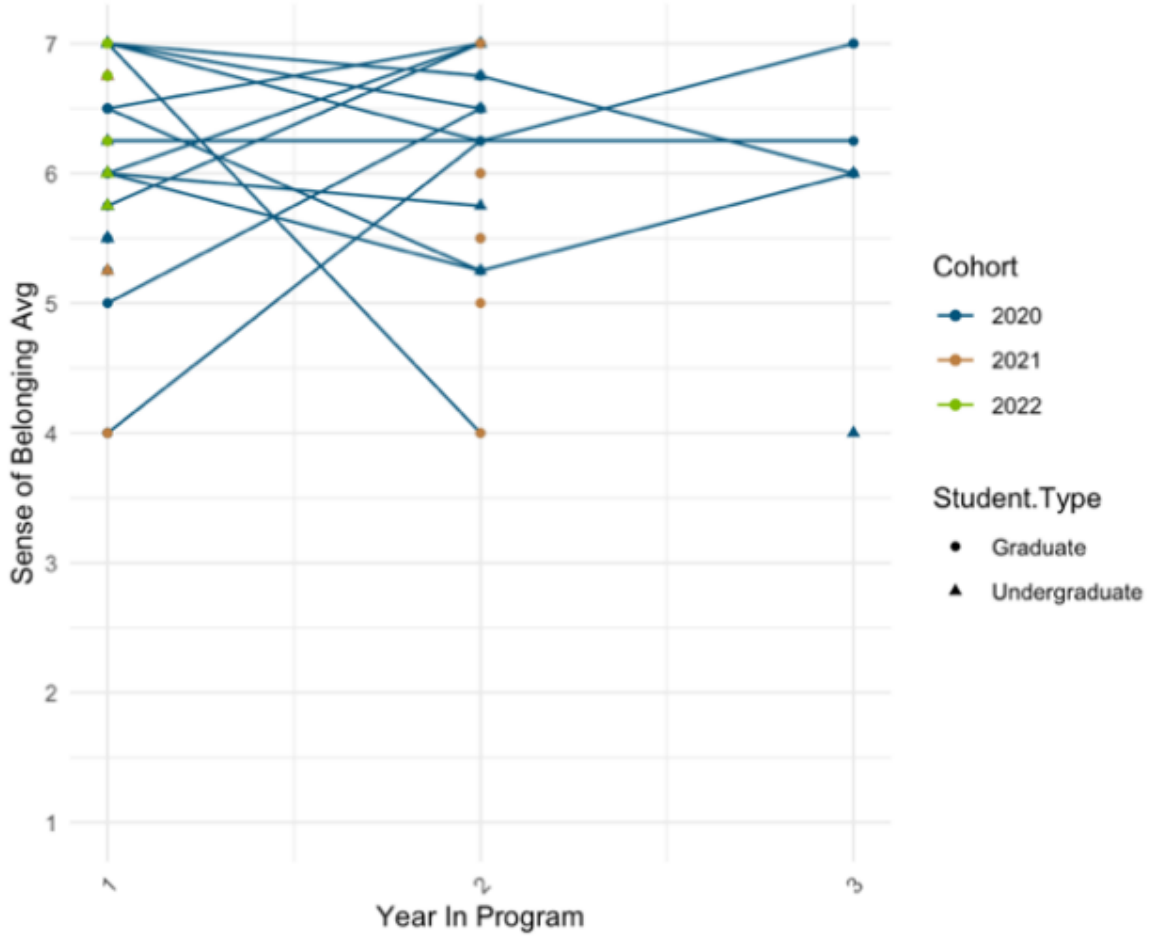

Figure 13. Key metric analysis across individual student IDs length in the program (continued). Graduate and undergraduate levels are distinguished, and graduate student levels include most Master and Doctoral students. Enrollment in the program is distinguished based on the date the student joined the grant. Cohort 2020 are all students who started during AY 2020-2021, cohort 2021 are all students who started during AY 2021-2022, and cohort 2022 are all students who started during AY 2022-2023. Cohort 2023 data will be collected at the end of the 2023-2024 Academic Year. Year in program represents which survey has been taken (1=Baseline, 2=Y2, 3=Y3). A. Survey respondents' responses to items related to Professional Technical Skills (scale 1-5). B. Survey respondents' responses to items related to Self-Efficacy (scale 1-6). C. Survey respondents' responses to items related to Sense of Belonging (scale 1-5). D. Survey respondents' responses to items related to Self-Efficacy (scale 1-5). E. Survey respondents' responses to items related to Persistence and Intentions (1-5).

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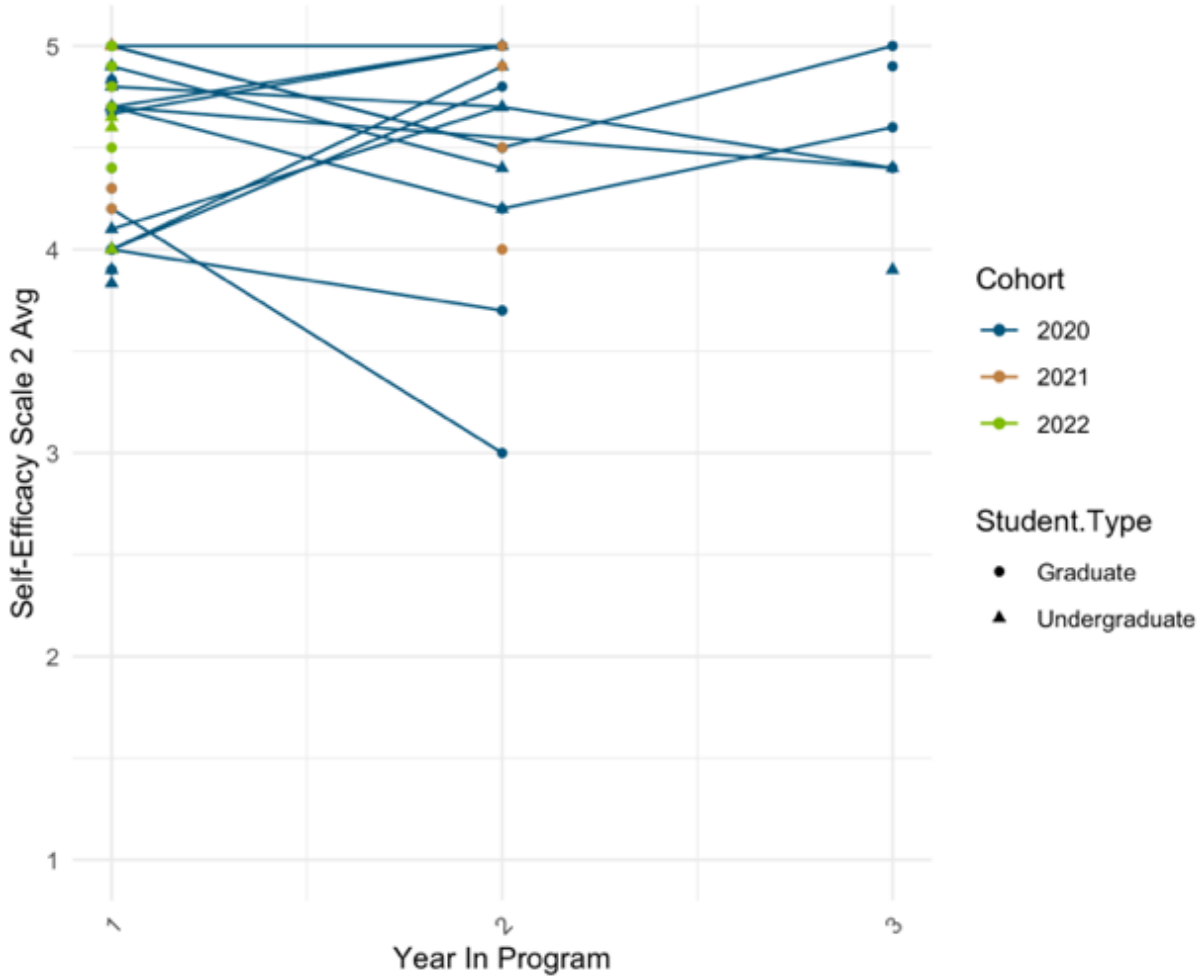


Figure 13. Key metric analysis across individual student IDs length in the program (continued). Graduate and undergraduate levels are distinguished, and graduate student levels include most Master and Doctoral students. Enrollment in the program is distinguished based on the date the student joined the grant. Cohort 2020 are all students who started during AY 2020-2021, cohort 2021 are all students who started during AY 2021-2022, and cohort 2022 are all students who started during AY 2022-2023. Cohort 2023 data will be collected at the end of the 2023-2024 Academic Year. Year in program represents which survey has been taken (1=Baseline, 2=Y2, 3=Y3). A. Survey respondents' responses to items related to Professional Technical Skills (scale 1-5). B. Survey respondents' responses to items related to Self-Efficacy (scale 1-6). C. Survey respondents' responses to items related to Sense of Belonging (scale 1-5). D. Survey respondents' responses to items related to Self-Efficacy (scale 1-5). E. Survey respondents' responses to items related to Persistence and Intentions (1-5).

E

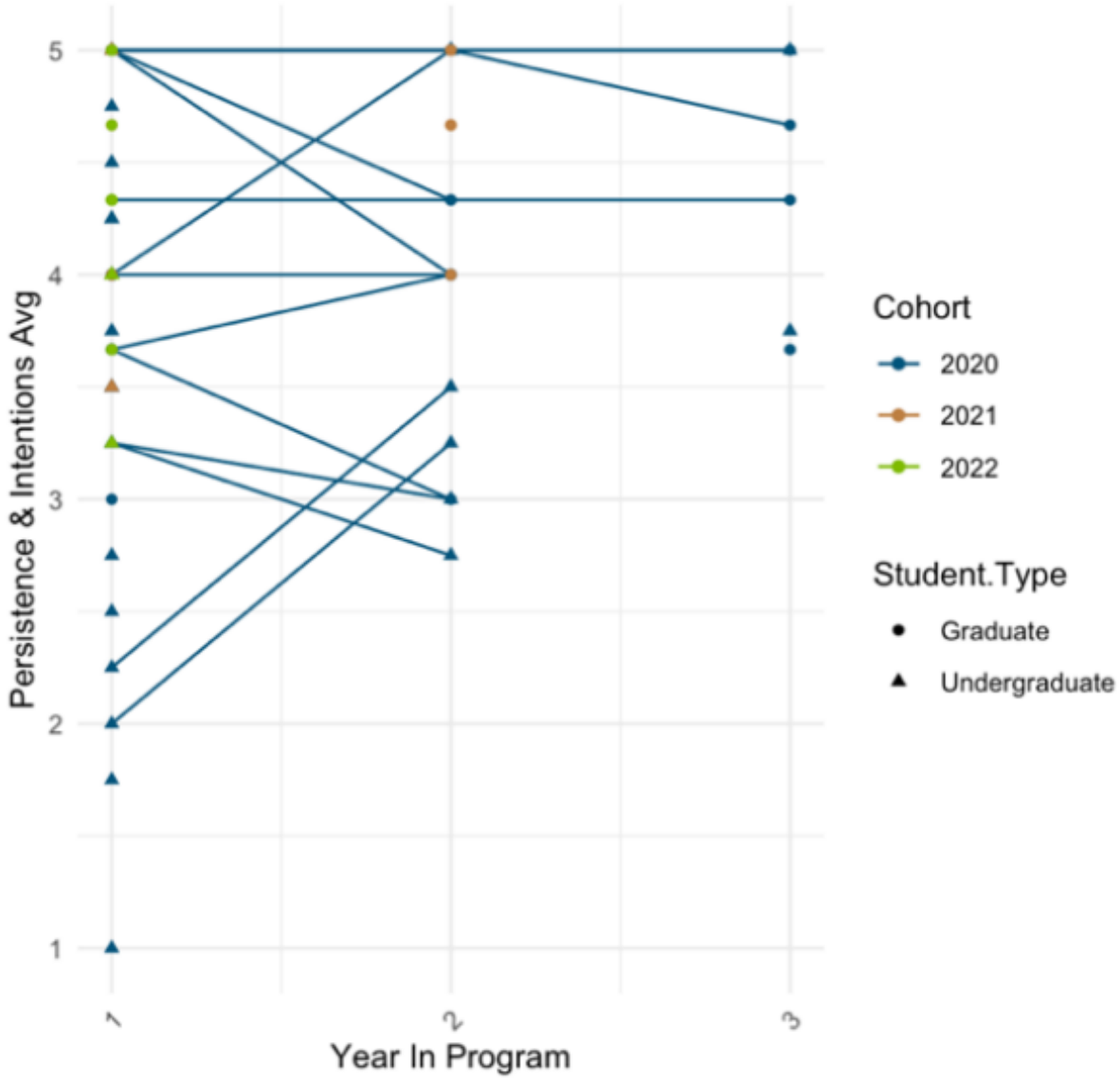
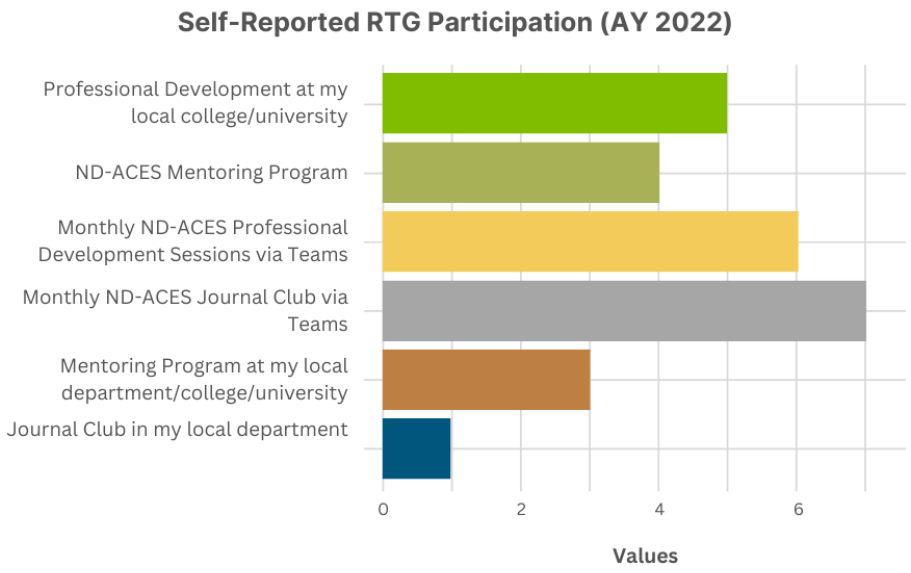


Figure 13. Key metric analysis across individual student IDs length in the program (continued). Graduate and undergraduate levels are distinguished, and graduate student levels include most Master and Doctoral students. Enrollment in the program is distinguished based on the date the student joined the grant. Cohort 2020 are all students who started during AY 2020-2021, cohort 2021 are all students who started during AY 2021-2022, and cohort 2022 are all students who started during AY 2022-2023. Cohort 2023 data will be collected at the end of the 2023-2024 Academic Year. Year in program represents which survey has been taken (1=Baseline, 2=Y2, 3=Y3). A. Survey respondents' responses to items related to Professional Technical Skills (scale 1-5). B. Survey respondents' responses to items related to Self-Efficacy (scale 1-6). C. Survey respondents' responses to items related to Sense of Belonging (scale 1-5). D. Survey respondents' responses to items related to Self-Efficacy (scale 1-5). E. Survey respondents' responses to items related to Persistence and Intentions (1-5).

Trends observable in Figure 13 detail individual student growth over the length of time in the program. While statistical significance is not able to be shown due to the low sample size and power analysis results, there are clear increases and decreases in student perceptions of their skills based on the key metrics. Most notably, professional and technical skills seemed to be the most successful in growth, with almost all students experiencing growth in their professional technical skills over the time they were enrolled in the RTG program. This trend is not as prevalent for the other key metrics. Sense of belonging, persistence, and intentions, and work self-efficacy were variable, with many students tracking a decrease in their abilities and/or confidence. It is important to note that tangential research experience was occurring along with the RTG programming, and the RTG program was designed to accompany and strengthen skills learned in a research setting.

Additionally, self-reported data was collected on participation in the program and various aspects of the RTGs. This was newly incorporated into the Y3 survey, so all self-reported data is only from Y3 survey respondents. Multiple options were available to select, and participation was listed as one or more attendance. In addition to self-reported data, in-person attendance was collected during the live RTG program components. It is important to note that journal club and professional development opportunities were all recorded and posted via Microsoft Teams, and it was not possible to collect asynchronous participation, if any occurred. Figure 14 shows the difference in self-reported participation and recorded live participation in RTG participants. There is a discrepancy between self-reported participation and recorded attendance, as recorded attendance was lower than self-reported attendance for all program components.

A



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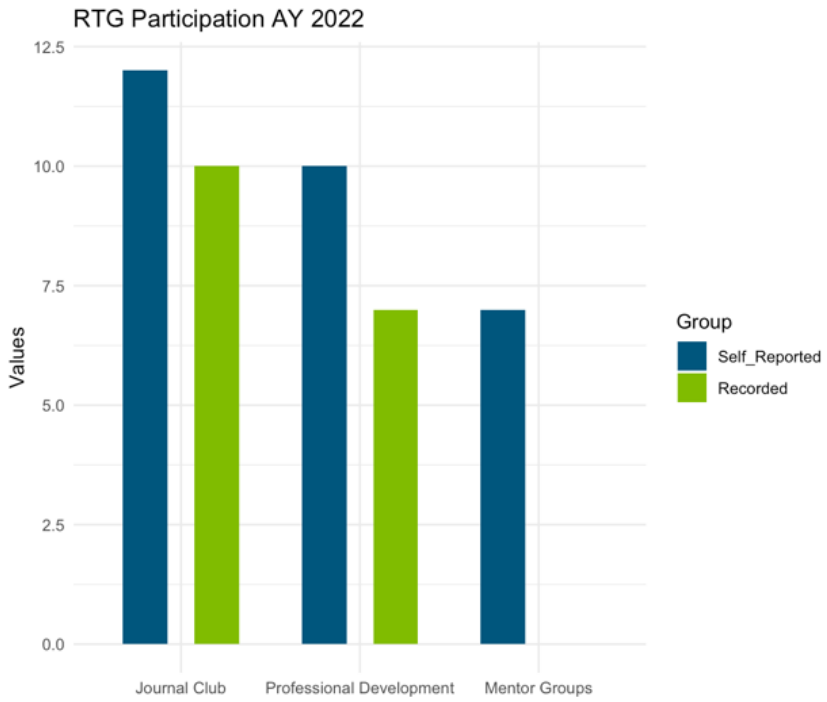

Figure 14. RTG Participation.
Self-reported in the Y3 survey (left) and recorded vs. reported for Y3 (right). Note that participation was not recorded or asked to be self-reported prior to AY 2022-2023

After reviewing the participation data, the aggregate key metric response data for Y3 was ran with comparison of confidence differences based on participation status. Table 4 shows the differences between participation groups. While the sample size of participants was much

smaller than non-participants, participants ranked higher in professional technical skills, work self-efficacy (scale 2), and persistence and intentions. It is important to note that all participants were solely graduate students, whereas the non-participants were both graduate students and undergraduates. Interestingly, students who had not participated in the live RTG program components reported higher feelings of sense of belonging.

Table 4. Participation status and key metric values.

Participants vs non-participants						
	N	Professional Technical Skills	Work Self-efficacy (Scale 1)	Work Self-efficacy (Scale 2)	Sense of Belonging	Persistence & Intentions
P	5	4.44	4.73	4.90	6.00	4.80
NP	15	4.23	4.83	4.54	6.32	4.36
Participants						
Key Metric Outcomes		Professional Technical Skills	Work Self-efficacy (Scale 1)	Work Self-efficacy (Scale 2)	Sense of Belonging	Persistence & Intentions
N		5	5	5	5	5
Mean		4.44	4.73	4.90	6.00	4.80
Std. Dev.		0.82	1.46	0.30	1.13	0.41
Non-participants						
Key Metric Outcomes		Professional Technical Skills	Work Self-efficacy (Scale 1)	Work Self-efficacy (Scale 2)	Sense of Belonging	Persistence & Intentions
N		15	15	15	15	15
Mean		4.23	4.83	4.54	6.32	4.36
Std. Dev.		0.94	1.01	0.61	1.03	0.90

Comparisons of participants (P) vs. non-participants (NP) in year 3 of the RTGs across the four key metrics. All participants (P) were graduate students (n=5), whereas non-participants were a mix of undergraduates and graduate students (3 UG, 12 G).

Since persistence and intentions to stay in STEM is a key metric, data was collected on previous RTG and dREU participants on whether they stayed in a STEM discipline or chose a non-STEM path using networking platforms such as LinkedIn. Figure 15 shows the proportion of

past RTG students who have entered the workforce compared to those who are still students and pursuing a degree. Of the previous RTG participants, 52.9% are currently working while 38.5% are enrolled as students.

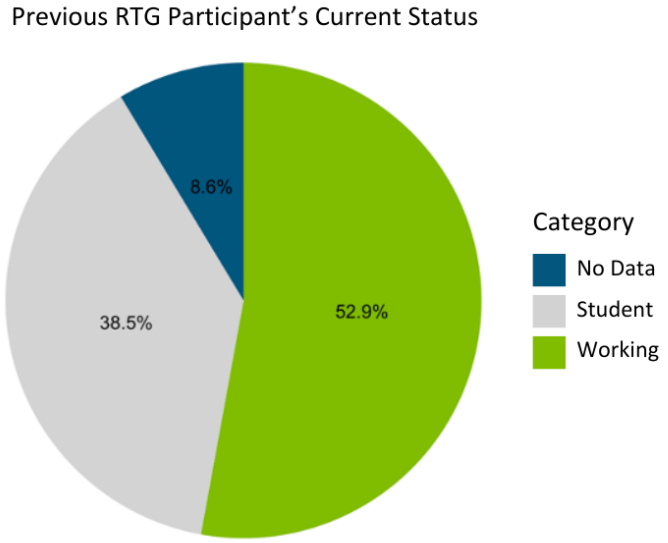

Figure 15. Past ND-ACES Students and their current work status.
Student includes any student still pursuing an undergraduate degree or a graduate degree.
Working is students who have entered the workforce.

Figure 16 shows the proportion of past participants that persisted in STEM, either in academic settings or in industry. Of the past RTG participants, 79.3% are in STEM (either working in STEM or pursuing a STEM degree), while 11.5% are not in STEM.

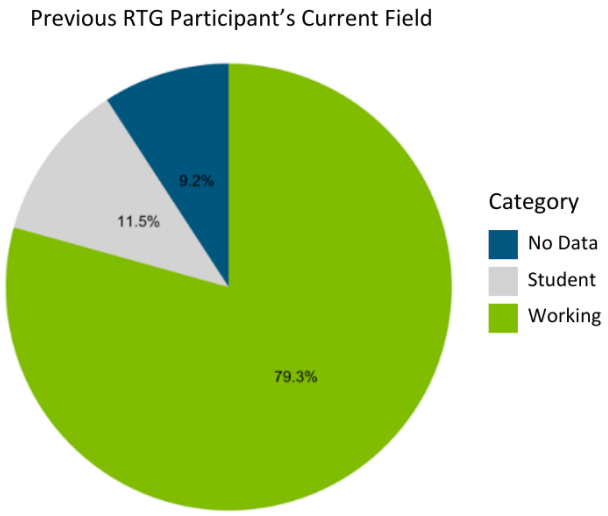

Figure 16. Previous RTG Participant's Current Field.
Aggregate data includes students in school pursuing a degree and in the workforce.

Finally, Figure 17 shows the proportion of past RTG students who have entered the workforce and whether they have pursued careers in STEM vs non-STEM. Of the past RTG participants who are in the workforce, 79.3% are working in a STEM career, while 20.7% are in a non-STEM field.

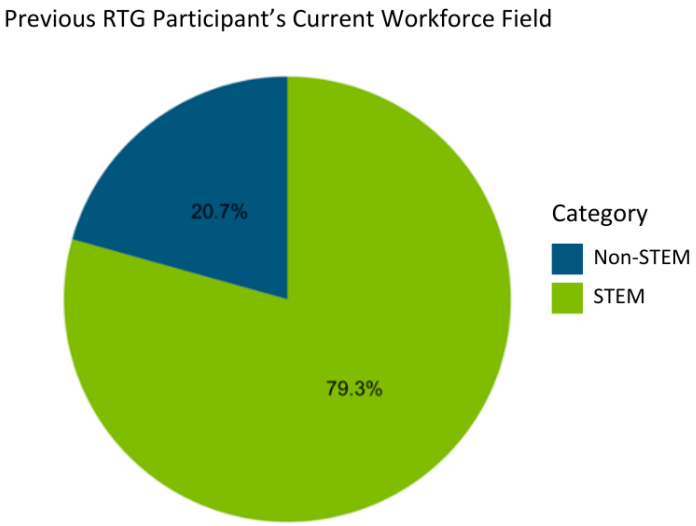

Figure 17. Previous RTG Participant's Current Workforce Discipline.

While direct comparisons cannot be made on the persistence of these students solely based on the RTG program, their experience in ND-ACES research and possible RTG programming may have contributed to their persistence in STEM disciplines. This data collected includes individuals working to fulfill the United States STEM workforce, as well as internationally. However, the vast majority of previous RTG participants have remained in the domestic and continental United States, fulfilling the STEM workforce needs at a rate almost double the national average(5). Additional analysis on student length in the program, participation in RTG programing, and the correlation to persistence in STEM may be a better indicator of the RTG program's influence on STEM persistence.

dREU program

In addition to surveying all the RTG participants, we collected data solely for our dREU participants based on six key metrics. Table 5 shows the aggregate averages of these metrics.

Table 5. Pre- and post-dREU experiences based on six key metric outcomes.

	N	Key Metric Outcomes	Oral Communication	Understanding Others' Research	Discuss Own Research with Others	Teamwork Skills	Written Communication	Ethical Research Ability
Pre-dREU	12	Mean	3.73	3.56	3.37	3.89	3.36	3.55
		Std. Dev.	.741	.833	.833	.891	.771	1.14
Post-dREU	9	Mean	3.88	3.67	3.89	4.11	3.73	3.97
		Std. Dev.	.916	.681	.738	.737	.831	.744

Although the sample size is small, these dREU students felt higher confidence in their oral communication skills, ability to understand research, ability to discuss their own research, teamwork skills, written communication skills, and their ability to detect ethical research processes. The dREU students were incorporated into the RTG program in its third year, so it is worth noting that one of the dREU students had access to the RTG program components and the

others did not. However, professional development was a component of the dREU program solely for those students before incorporation into the RTG program and subsequent RTG professional development.

Figure 18 displays the differences in pre- and post-dREU experience for five different skill metrics: skill confidence, discussing research, ethical research practice, teamwork, and understanding research. Although the sample size was too small to run statistical analysis, trends can be observed for changes in individual dREU confidence for five different key metrics. While both pre- and post-survey responses were almost all 3-5 on the Likert scale, there were observable plateaus, increases, and decreases in all of the key metrics. Skill confidence (Figure 18A), discussing own research (Figure 18B), ethical research skills (Figure 18C), teamwork skills (Figure 18D), and understanding others' research (Figure 18E) all had mixed trends observed: some students did not report a change in their skill, while some reported an increase or decrease from pre- to post-dREU experience.

A

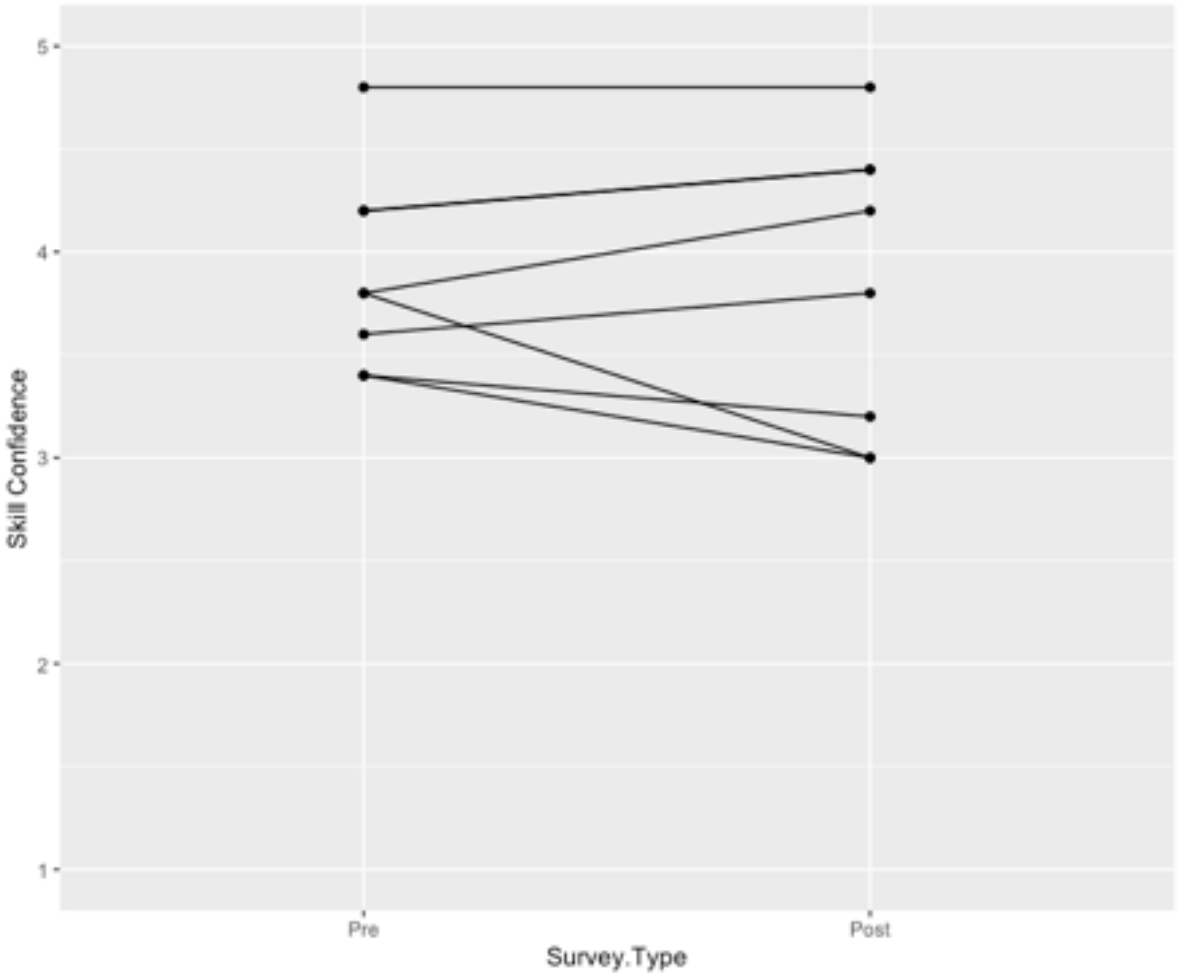

Figure 18. Pre-dREU vs post-dREU experience for students enrolled in the program. Only students with both pre- and post- data are shown for accurate comparison. A. Rating own confidence on various skills compared to the average college student. Scale of "I am in the bottom 10%" (1) to "I am in the top 10%" (5). B. Rating ability on various skills related to discussing own research topics with others. C. Rating ability on various skills related to understanding others' research. D. Rating ability on various skills related to teamwork skills. E. Rating ability on various skills related to ethical research skills. B-E on scales of "None" (1) to "Extensive" (5).

B

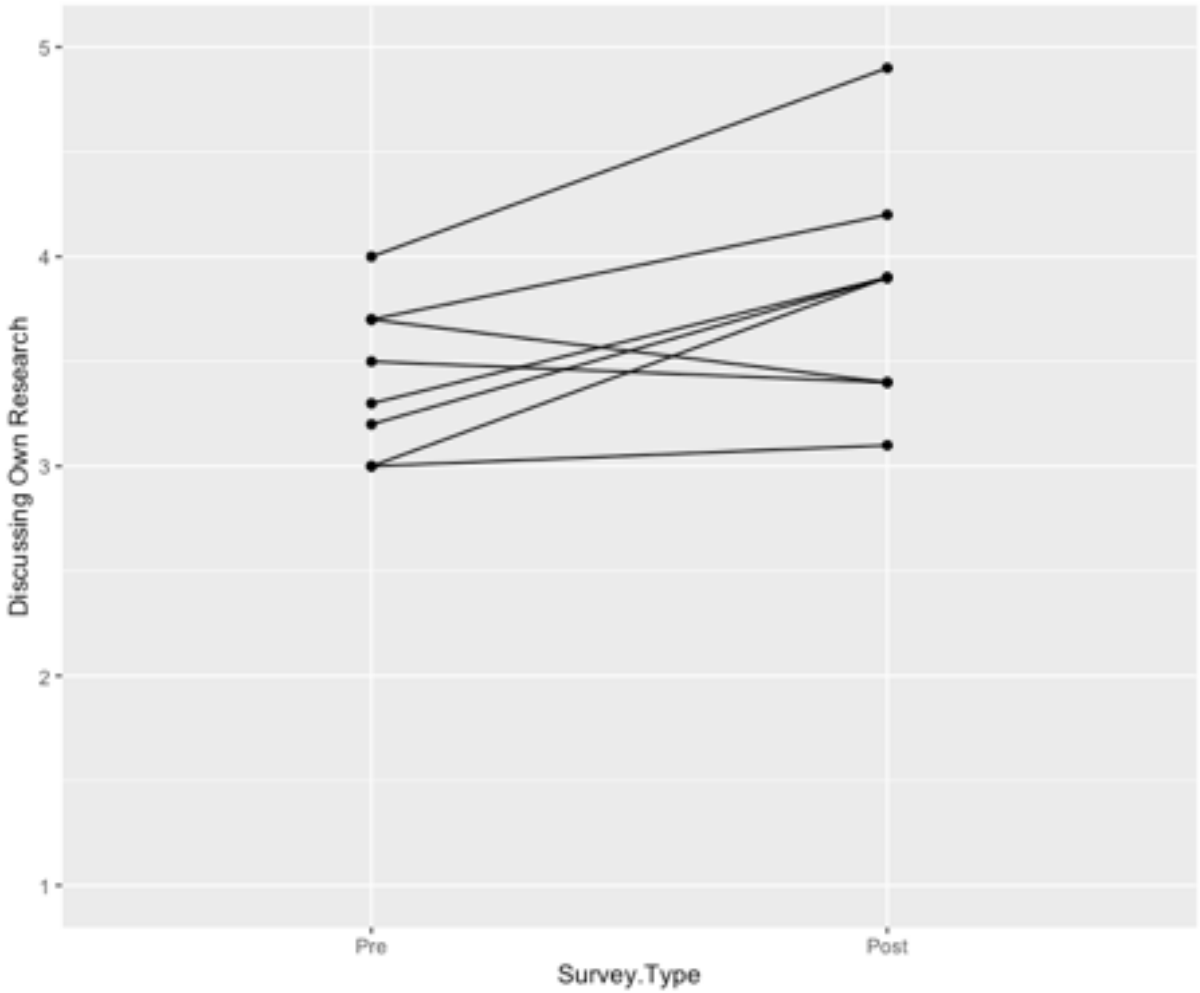

Figure 18. Pre-dREU vs post-dREU experience for students enrolled in the program (continued). Only students with both pre- and post- data are shown for accurate comparison. A. Rating own confidence on various skills compared to the average college student. Scale of "I am in the bottom 10%" (1) to "I am in the top 10%" (5). B. Rating ability on various skills related to discussing own research topics with others. C. Rating ability on various skills related to understanding others' research. D. Rating ability on various skills related to teamwork skills. E. Rating ability on various skills related to ethical research skills. B-E on scales of "None" (1) to "Extensive" (5).

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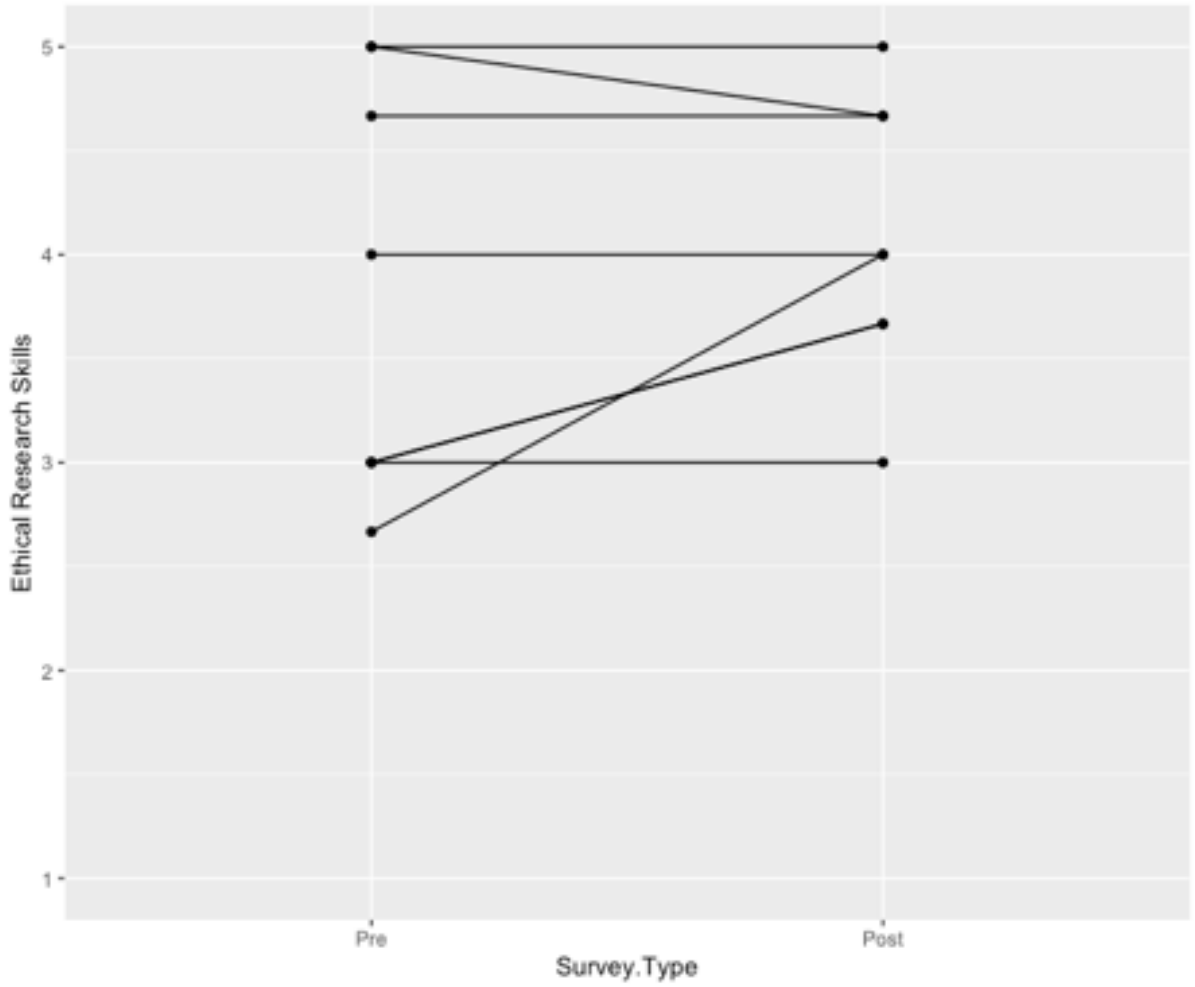

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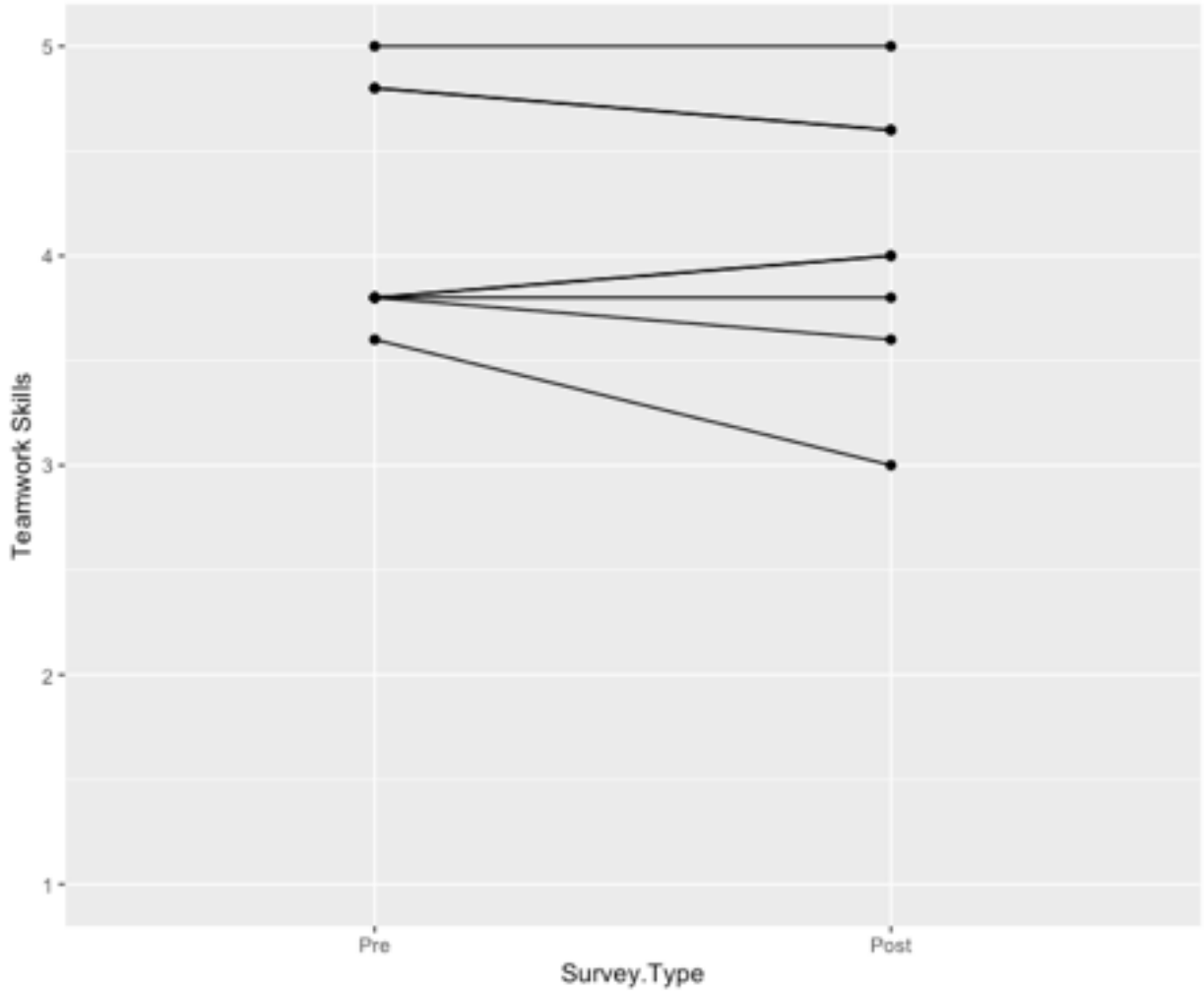

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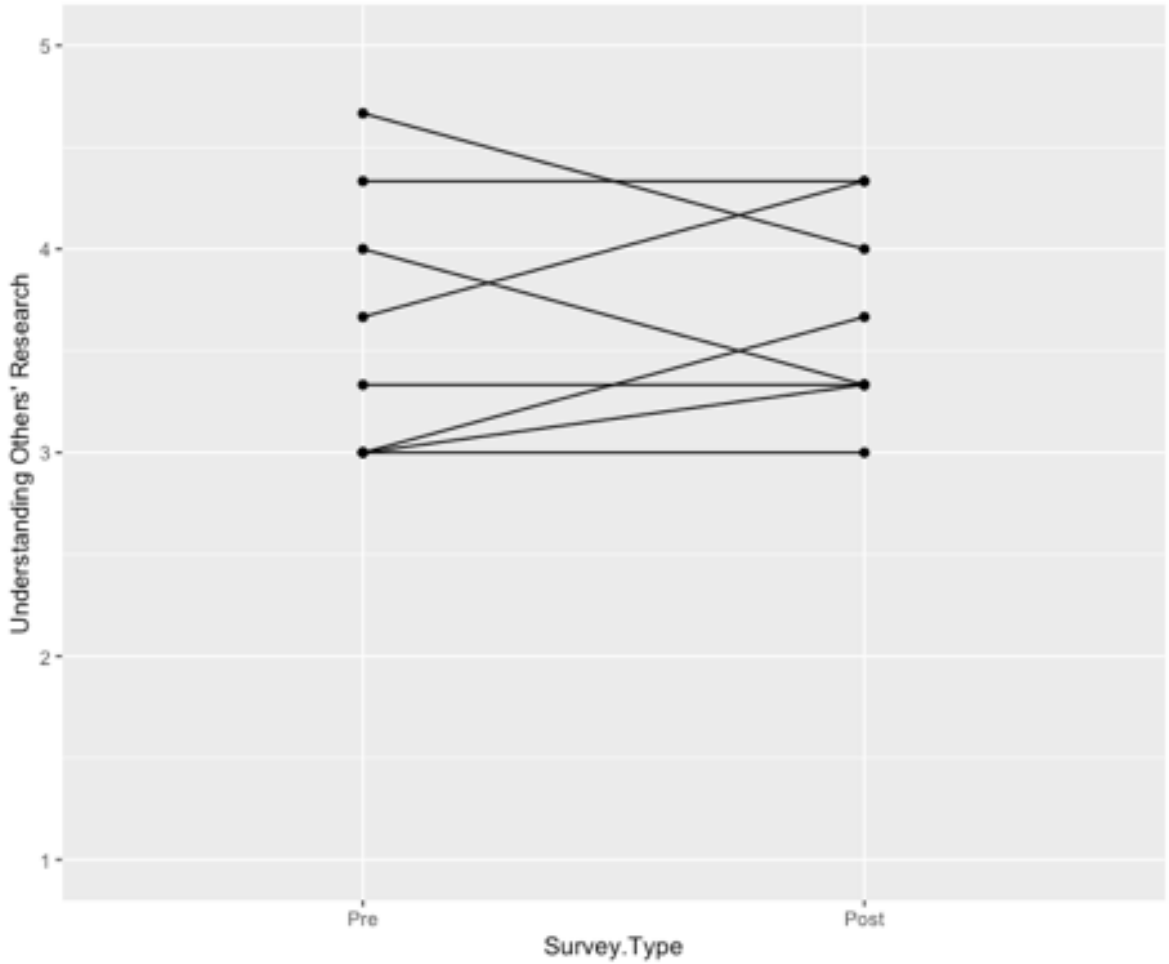

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In addition to quantitative questions, there were multiple qualitative data-seeking questions asked in the post-dREU experience, with common themes observed among the responses. Tables 6-8 report the observed themes. Almost all themes were positive, with a few negative experiences with mentorship and/or support (Table 7 and 9), and with workload expectations (Table 7).

Table 6. Observed themes related to similarities/differences between summer and academic year research.

Please comment briefly on the similarities and differences between summer research and academic year research:		
Differences observed for time commitment and/or time available for research. (6)	Only participating in one and having no experience with the other. (3)	Both were similar, with no specific reasons identified. (1)

Table 7. Observed themes related to the dREU experience and expectations.

In what ways did the research experience meet or not meet your expectations?				
Expectations met for academic and/or career goals. (4)	Expectations met for mentorship and networking. (2)	Insufficient mentorship and/or support. (2)	Workload was more than expected. (1)	Expectations met for research skills gained. (1)

Table 8. Observed themes related to their dREU research supervisor.

What informed your rating of your supervisor's performance?		
Had a supportive, helpful, and guiding mentor. (6)	Received a lack of guidance and communication from supervisor. (2)	Experienced facilitation of skill growth and development. (1)

Table 9. Observed themes related to satisfaction with the dREU experience.

Why were or weren't you satisfied with your research experience?		
Satisfied with the skills and knowledge gained. (6)	Achieved or reached personal and/or academic goals. (2)	General satisfaction, but frustration with research mentor. (1)

While the focus of the dREU program was not inherently to increase STEM persistence through graduation and into the workforce, dREU students were exposed to the RTG or professional development program components that focused on this mission. Data was collected to determine the proportion of students who were persisting and chose STEM careers.

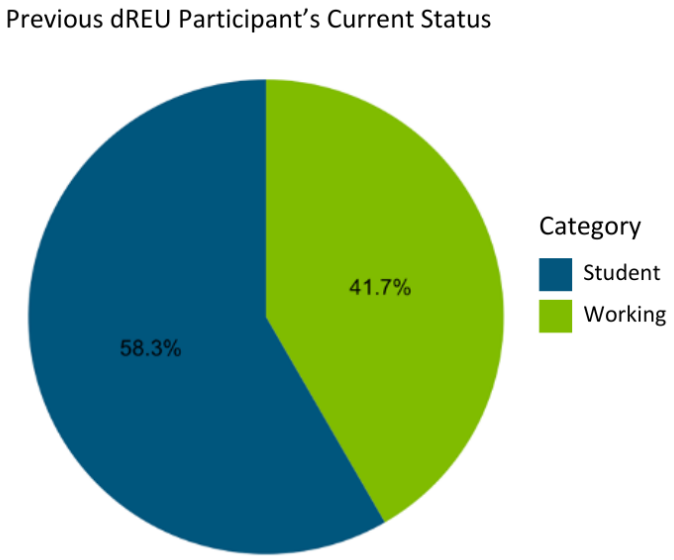


Figure 19. Proportion of past dREU Students and their current status.
Student includes any student still pursuing an undergraduate degree or a graduate degree.
Working is students who have entered the workforce. N=12.

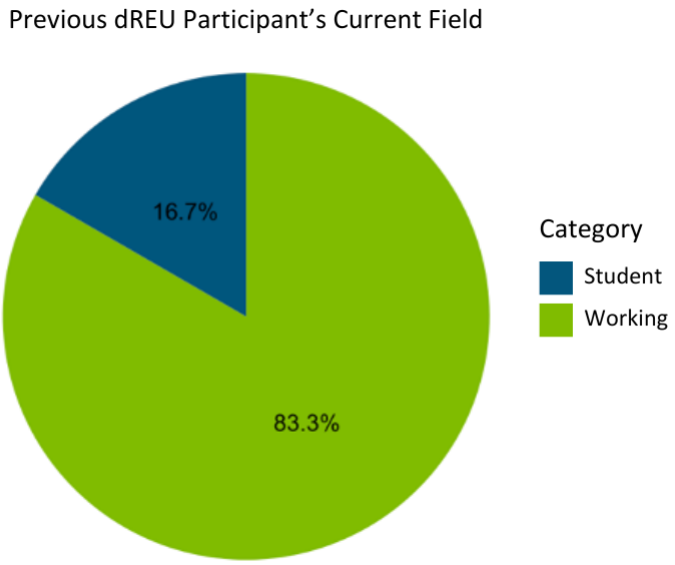


Figure 20. Aggregate data of what fields past dREU students are currently in.
This includes students in school pursing a degree and in the workforce. N=12.

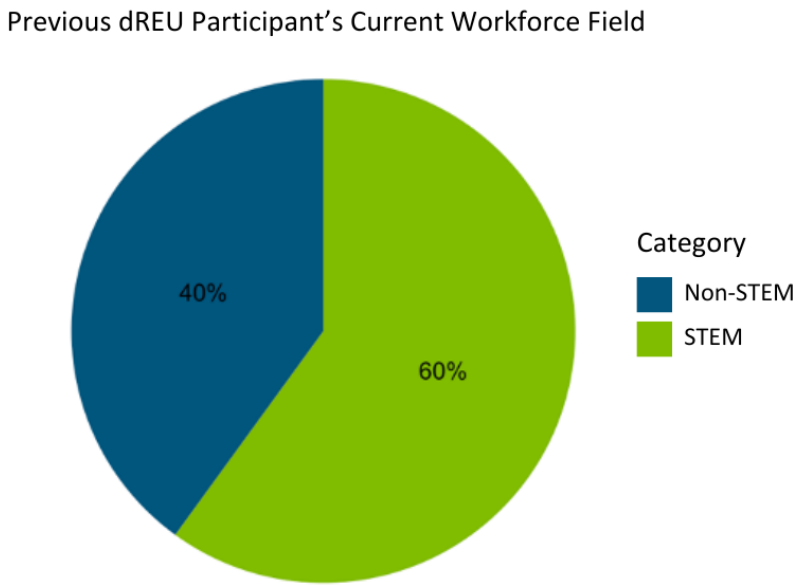


Figure 21. Previous dREU Students current workforce field.
Only includes students that have entered the workforce and whether they have persisted in STEM fields or have entered jobs in non-STEM fields. N=5.

Although the N for students in the dREU program was much lower than that of students who participated in the RTG program as a whole, some differences can be observed between the two groups. DREU students were more proportionately still in school (Figure 19), as opposed to entering the workforce as seen for RTG students (Figure 15). Of those students who were working, a smaller proportion of them were in STEM workforce fields compared to the RTG participants (Figure 17). However, when combined for both degree and workforce field, a greater percentage of dREU students were in STEM paths than RTG participants were (Figure 20 and 16, respectively). It should be noted that there were RTG participants where data was not found and could mitigate these gaps if that data was available.

Discussion

It was surprising to see the initial high rankings for individuals in the first year of this RTG program (Table 2 and Figure 13). Normalizing the data to compare growth for each individual across each other rather than their numerical responses likely mitigated much of the

difference in perception of Likert scale values. However, the high rankings (4.5-5) for many of the metrics for individuals in their first year of the program was unexpected. There is a likely potential for overconfidence bias in self-reporting. If that is the case, it could explain the significant decreases in subsequent survey responses for the key metrics, as overconfidence has been shown to lead to underachievement (68). Potential programmatic changes to the RTG components could include professional development on mindset and managing dissonance to reduce overconfidence bias (69, 70). Additionally, utilizing a peer-comparison format for survey questions can help identify overreplacement and predict potential overconfidence in survey respondents (71). There are also caveats that come with self-reported data: evidence was collected that there was over-reporting of participation in RTG program components when compared to collected attendance data. Although some elements were recorded and attendance of asynchronous participation is not possible to collect, there were elements of the program that had higher self-reported attendance than actual attendance.

An additional caveat to mention is that due to the fluidity of enrollment in the RTG program, it is difficult to compare the impact of the program over time. Significance of current differences would require a much larger sample size (as determined by the power analysis), so drawing conclusions between cohorts is difficult. In addition, differences in student performance, success, and development cannot be determined solely by the RTG program due to no negative control program, and the various experiences that each student may be exposed to at their own institution and research lab experience.

Despite these drawbacks, trends can be observed and utilized to improve the future of this program. Firstly, the dREU program data showed that students were pleased with their experience, and they observed growth in their skillsets. While this program could be considered

successful based on these outcomes, poor mentorship/guidance was a common theme observed in the qualitative data. Future program implementations should include mentorship training for future dREU research supervisors, conflict resolution support for the dREU students, and better resources for mentor/mentee relationships. Additionally, building a network of mentors would better serve student success, as not one individual can fulfill all the mentoring needs of a mentee (72).

Secondly, the RTG program data displayed a potential for overconfidence, which may allude to poorer skills in self-analysis. Introducing program components that encompass reflection, self-evaluation, and mindset would be beneficial to mitigating these influences in the future. A greater ability to reflect and gauge one's skills accurately could lessen the decreases seen in the metrics. An additional survey of the RTG participants mentors regarding their student's skills would identify the differences between student self-evaluation and supervisor's evaluation, likely bridging this gap – and would possibly be a more accurate representation of the student's skillset. If this program were to be adopted for another Track 1, having a control group of students not in the RTG program would help identify differences in students with the resources vs. students without, better alluding to the influence of the program on student development and growth.

Finally, future implementations could encompass a survey redesign. While individual growth tracking normalizes the differences in Likert scale perceptions, there are likely better ways of collecting similar information. Implementing a qualitative scale that corresponds to Likert values as opposed to solely using Likert values would help with the different perceptions and allow students to gauge their true skill level more accurately. In addition, incorporating a qualitative question after the scaled questions (similar to the dREU qualitative questions) would

allow for identifying underlying themes that would correspond to the more positive or negative responses. These themes would then better help identify the influence of the RTG program on participants and potentially inform adaptations to improve the RTG program. Finally, for a program such as the one displayed by RTG to work, there needs to be buy-in for both students and research advisors. Including incentives (such as funding opportunities) or requirements (such as in contracts) may improve participation and subsequent impacts of the program components. Whether the "carrot" or the "stick" would be a more appropriate methodology for encouraging behavior, a combination of both approaches would likely be the most effective in encouraging specific behavior (73). This would serve as a potential area for improvement in future Track-1s and subsequent research with an increased N to be able to statistically analyze the results and impact.

The RTG program serves as an example of formats for providing support for undergraduate and graduate students in their academic journey. Mentorship, professional development, and building community amongst students themselves are beneficial for student retention and persistence, and this serves as a potential framework for departments or academic colleges to initiate within their own institution. Having a centralized communication location (Microsoft Teams, as used in ND-ACES), and providing access to resources to enhance student success will encourage student persistence and retention, and work towards fulfilling the demanding and growing workforce needs that STEM fields require.

CHAPTER 3: IDENTIFYING DEPARTMENTAL CLIMATE AS A TOOL TO DEVELOP RETENTION INITIATIVES FOR STUDENTS AND EMPLOYEES

Introduction

Retention in higher education has been extensively studied for decades. Despite the extensive literature, theoretical models, and researched solutions, retention of students in higher education has remained mostly stagnant over the last ten years (74). Student retention is vital for many reasons. Aside from increasing the number of graduates from a program, keeping students in a program has important economic contributions, both to the student and to the university or department (30). Students who are retained in their program are also more likely to persist in a given field (41), which is vital for students fulfilling the growing workforce needs, especially in STEM fields (3). Attrition of students causes negative financial impacts on the student and the institution, as well as not fulfilling the demanding workforce needs. Retaining students oftentimes leads to an increased number of students participating in research (75), and more successful research outcomes when supportive resources are in place (76), which is important for higher education institutions that prioritize research productivity, such as R1 institutions. While retention of students is often used as a key performance indicator of university quality and success, the same could be said at the departmental level, where retention can serve as an indicator of the quality and success of each program.

Many theoretical models have been produced with retention as the scope to characterize why students choose to leave higher education. Bean's Student Attrition Model ascribes attrition to shortcomings within the individual and was the first to identify similarities between student and employee attrition (11, 16). Although theoretical models are not always the easiest to apply

as retention is highly variable, Bean (1980) drew on an important concept often overlooked in retention literature: the effect of institution employees on student retention.

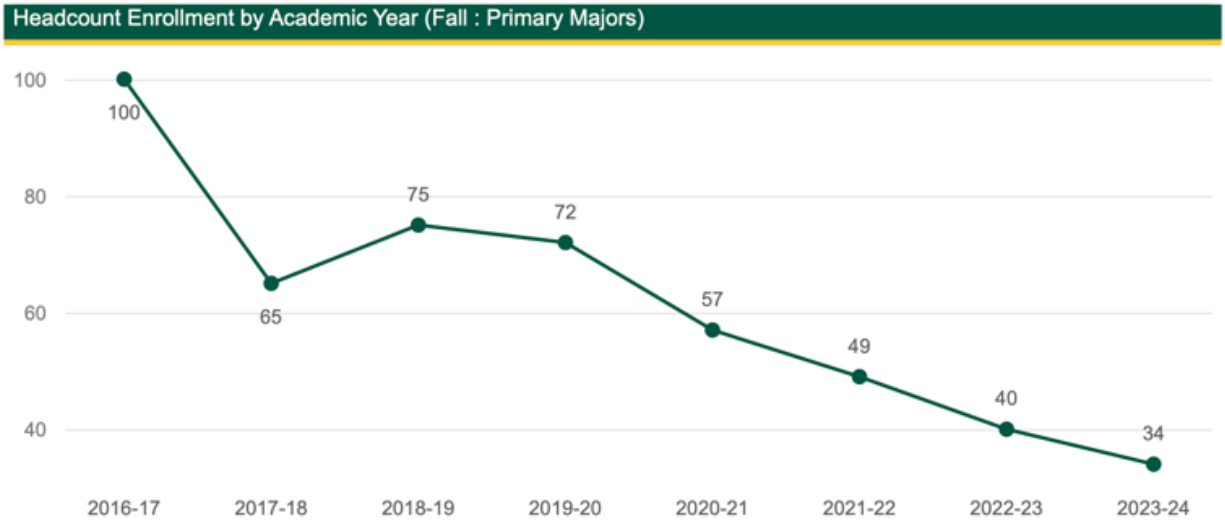
Employees at a higher education institution have considerable impact on the student experience, and subsequent student retention. As Figure 9 from the literature review section alludes (showing a perturbation in the retention system), faculty and staff often engage in and provide student-facing services that have downstream influences on student retention. While employee retention is not considered in the systems map, it is important to consider for management and leadership to prevent student attrition. Organizational climate has been shown to influence employee retention, with training, development, well-being, and environment as influential predictors (77).

Identifying cultural or climate issues within an academic unit is a step in developing interventions to make the environment more welcoming, collaborative, and supportive for all members (78, 79). As observed in Chapter 1, it is important to prioritize both students and employees when considering retention metrics. While literature often discusses retention through the lens of the higher education institution as a whole (11), it seems logical to be able to view the same trends at a college or departmental level. Not having a clear understanding of a target population's respective needs makes any retention initiatives challenging and not as successful as targeted solutions (59). Previous published data from other departmental climate surveys displayed a gap in student success metrics compared to their research advisor success metrics (43). Additionally, climate surveys can be used to identify any value dissonance between department members and student, and mitigating this dissonance can improve student academic performance (80). Aligning climate and culture can positively impact student persistence (and consequently retention, as seen in Figure 1) (81). Therefore, climate surveys can be used to

identify climate, potential areas for specific improvements at the departmental level, and solutions to align climate and culture. This will subsequently influence the retention of both students and employees within a department.

Scope of study

The Department of Microbiological Sciences serves as the scope for this study. Contained within the College of Agriculture, Food Science, and Natural Resources (CAFSNR) at North Dakota State University (NDSU), the Department of Microbiological Sciences has been struggling with both enrollment and retention declines. This trend of enrollment declines is not specific to the department, as the institution has been facing enrollment and retention declines for almost a decade. Figure 22 shows the compound annual growth rate for the department shows a 15% decrease from the previous academic year.



1-Year Compound Annual Growth Rate (CAGR)

Acad Career/Acad Sub-Level/Acad Class	Headcount (Current Year)	Headcount (1-Year Prior)	1-Year Diff	1-Year CAGR
Undergraduate	**34**	**40**	**-6**	**-15.0%**
1st Time, 1st Year (UGRD)	**5**	**4**	**1**	**25.0%**
Freshman	3	2	1	50.0%
Sophomore	2	2	0	0.0%
Transfer In	**0**	**2**	**-2**	**-100.0%**
Freshman	0	1	-1	-100.0%
Junior	0	1	-1	-100.0%
Returning Freshmen	**1**	**1**	**0**	**0.0%**
Returning Sophomore	**4**	**12**	**-8**	**-66.7%**
Returning Junior	**12**	**5**	**7**	**140.0%**
Returning Senior	**12**	**16**	**-4**	**-25.0%**
Total	**34**	**40**	**-6**	**-15.0%**

Figure 22. Trends in enrollment and 1-Year compound annual growth rate (CAGR) for the Department of Microbiological Sciences.
While the trends in enrollment are from the last eight academic years (AY), the CAGR is comparing the 2023-2024 to the 2022-2023 AY. Data from NDSU Office of Institutional Research and Analysis PowerBI (82).

Figure 23 shows the retention rates of undergraduate students from Fall 2021-Spring 2023 for the Department of Microbiological Sciences. In addition to enrollment declines, the retention rate of the department is around 82% for undergraduate students. This rate of retention is lower than the national average of 87.9% for the same postsecondary student cohort in a public

4-year institution (74). While enrollment declines are not specific to the microbiology department and follow a campus-wide trend for the eight academic years (83), decreasing retention rates are a campus-wide (Figure 24A), CAFSNR-wide (Figure 24B) and department-wide problem (Figure 23).

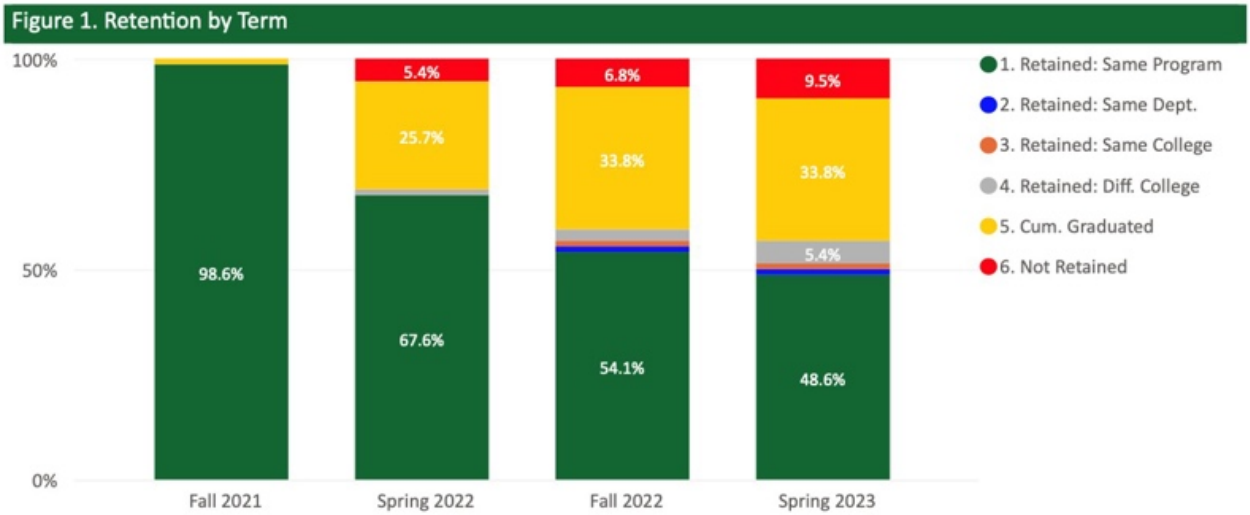
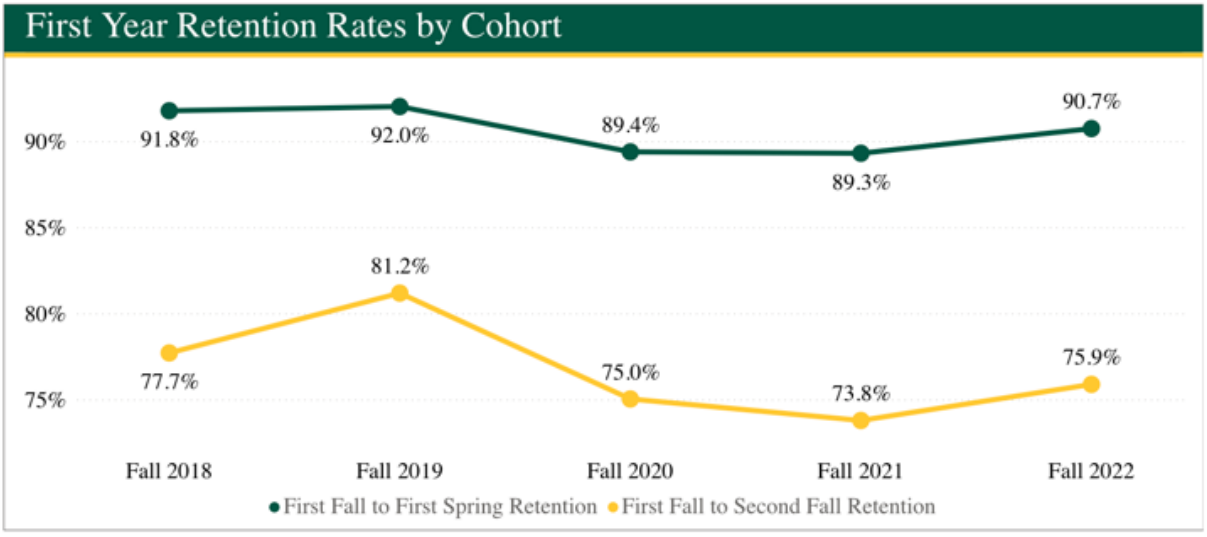


Figure 23. Differences in retention for the Fall 2021 student cohort in the Department of Microbiological Sciences.
These students would be set to graduate in four years in spring 2023. Data from NDSU Office of Institutional Research and Analysis PowerBI (84).

A



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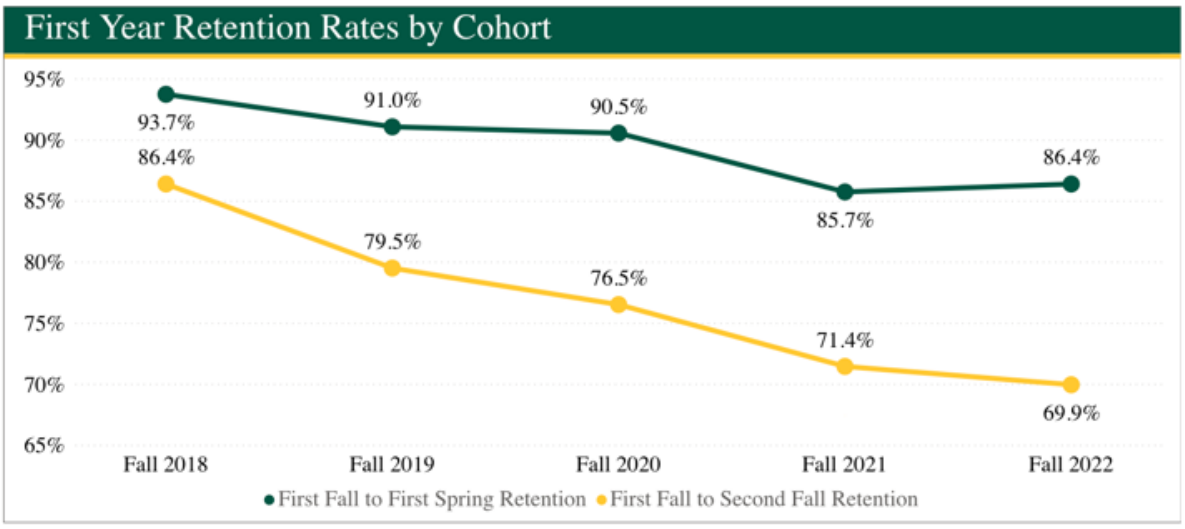

Figure 24. Retention rates of undergraduate students as a campus average (3A) and within the College of Agriculture, Food Science, and Natural Resources (3B).
Data from NDSU Office of Institutional Research and Analysis PowerBI (83).

While enrollment and retention trends identify an issue, it does not provide any beneficial information on how to reverse those trends. Preliminary data has been collected via an exit survey administered to students leaving the microbiology program. Of those who responded to the exit survey, 71% were graduating and 29% were either transferring to a different institution or a different program within the same institution (see Figure 25). Students who were not

completing their degree stated their rationale for leaving was transferring majors and/or schools that were more relevant to their academic goals and skills for success in future fields.

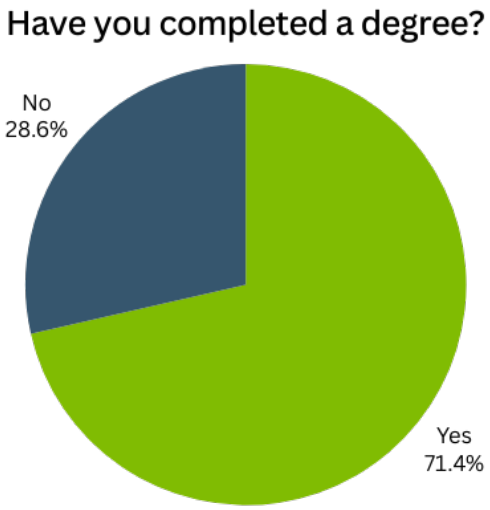

Figure 25. Proportion of exit survey respondents who graduated from the microbiology program. Students who did not complete this degree transferred to either a different major or different institution. N=7.

Additional qualitative data related to student experience in the Microbiology program was collected in the exit survey. Concerning advising, students noted both positive and negative experiences with advisor's knowledge and preparation to support students. Some comments also praised the communication skills of their respective advisors. In terms of treatment of students, students felt a sense of care, organization, and welcoming environment from their interactions. When discussing specific courses, students valued courses that contributed to their future preparation and/or courses with positive instructional quality. In contrast, students disvalued courses that did not contribute to their interests, future goals, or courses with poor instructional quality.

When discussing classroom learning environment, many students commented on positive classroom experiences, recalling how their professor(s) were caring, approachable, and had good

teaching quality. Even students who did not enjoy the content enjoyed the class because of the professor's engagement with the students. However, a student discussed poor quality of instruction, feeling a lack of care, approachability, and respect from their professor. Many of the classes and instructors mentioned varied, but this response alludes to the greater variability in learning experience for students in the department and warrants further investigation.

While the exit survey is preliminary data that aids in determining how exiting students feel upon leaving, no data exists for current students – or faculty and staff, for that matter. Identifying areas of need or discourse for current institutional members via climate surveys is one avenue for creating targeted improvements for retention. Although climate surveys have been administered on an institutional level, departmental climate surveys would better identify areas for improvement within the academic unit. It is important to identify current climate, notably for employees, to influence student retention more effectively. Employee development and job satisfaction are high impact retention initiatives (Figure 9) as negative outcomes of these have a large downstream effects. This makes focusing on employees important not only for themselves, but for students. Identifying areas of strength within an academic unit allows leaders to capitalize on these elements, and identifying areas for improvement allows leaders to implement solutions more effectively. Trends observed from climate survey data can help identify potential real-time perturbations within the student retention system (Figure 8), which can better identify effective and individualized retention interventions to prevent student attrition.

Methods

Survey design

A survey was designed to gain an understanding of the climate within the Department of Microbiological Sciences under protocol #IRB0004980. The goal of this survey was to identify perceptions of staff, students, and faculty that can be targeted for improvement and serve as a retention tool for both students and employees.

Due to the limited evidence of current retention or climate issues, this initial pilot survey was designed to explore numerous metrics that could influence these aspects. Specific questions regarding underrepresented groups (URGs) were utilized from a previously validated climate survey (78) to identify values and potential equity and inclusion gaps. Additional questions utilized specific theoretical frameworks for inception. Components of the Student-Faculty Informal Contact Model (85), specifically in terms of institutional factors, the Institutional Departure Model (14), and the Student Attrition Model (16) were used to guide questions. While these models were not necessarily applied, they were a resource of what to infer from question responses to guide potential retention interventions. Questions were geared towards identifying feelings related to belonging, value, trust, efficacy, inclusivity, and student-faculty values, with a goal to identify potential perturbations to the retention system as seen in Chapter 1.

The survey designed was primarily Likert scale questions as these questions were designed to measure attitude. These quantitative questions were either 5-point Likert scale responses (*Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree*) or 1-10 scaled questions (*Poor to Excellent*). All quantitative questions were forced choice. Specific quantitative questions prompted qualitative responses to elaborate on the respondent's value, and these qualitative questions were optional. Participant study consent was collected and included

the ability to leave the survey at any time. Only respondents who fully finished the survey were included in analysis. General demographic information was collected at the conclusion of the quantitative and qualitative survey sections. See Appendix B for the full survey.

Survey distribution

This survey was distributed via email communication to all students, staff, and faculty enrolled or employed within the Department of Microbiological Sciences and was open for fourteen days in the fall 2023 semester. The undergraduate student response rate was 11.1% (7/63), the graduate student response rate was 50% (16/32), the faculty response rate was 90% (9/10), and the staff response rate was 55.6% (5/9). It is important to note that four questions did not populate properly for the graduate student respondents, resulting in them not seeing the questions. Because of the vital nature of those questions, they were re-administered in their own survey. Since all questions were discrete (aside from those with follow-up qualitative responses, which did not conflict with the four survey questions) it was deemed appropriate to resend those questions without their responses impacting their previous survey submission. The response rate was 44% (14/32) for those four questions.

Statistical analysis

All data was analyzed using R. Quantitative data was organized using Likert scale models with general proportions of each response scale. Qualitative data was analyzed using conventional content analysis (67) with triangulation to increase validity. A power analysis was done on the data set and, due to the low N values of each study cohort, no statistical analysis was performed.

Study caveats

It is important to note that the Biotechnology program (major and minor) became a subset of the Department of Microbiological Sciences during a university academic reorganization during the 2022-2023 academic year. However, as this reorganization occurred during the process of this project, only data for the Department of Microbiological Sciences (and therefore only microbiology students) was collected in both PowerBI and climate survey data to keep a more consistent comparison. Future climate surveys should incorporate these new students as they are recognized members of the department.

In order to protect identity and increase the security of responding with true opinions, respondents were not prompted to input any identifying information short of demographic questions. Due to the anonymous nature of the survey, there is the possibility, although highly unlikely, that an individual could have taken this survey twice. However, the survey was designed so that the same IP address could not take it twice to minimize this possibility. The sample size of all cohorts was small, which made analysis based on demographics or other factors (such as first-generation status) impossible as cohort populations were below the analysis threshold. There may be implications to the results based on individual experiences that cannot be separated out with this dataset.

Additionally, there are limitations with the survey design. While a Likert scale was utilized to measure attitude, there is research to support that it is not as reliable or representative of complex human opinions (86). Responses are not always balanced between intervals, and responders display a tendency to avoid extreme responses (87). Other survey design methods, such as using a Guttman response, has been shown to increase content validity (88) and can be

created using a Likert response-style base (89). Future iterations of the climate survey may consider converting questions to the Guttman response.

Results

Undergraduate students

Undergraduate students were surveyed and their results are displayed below. Figure 26 highlights undergraduate responses for questions related to belonging, resources, and their learning environment. All undergraduates feel positive regarding having access to resources they need to be successful and feeling included in the department. 86% of students feel satisfied with their learning environment, and 71% feel welcome and included in their academic college of CAFSNR.

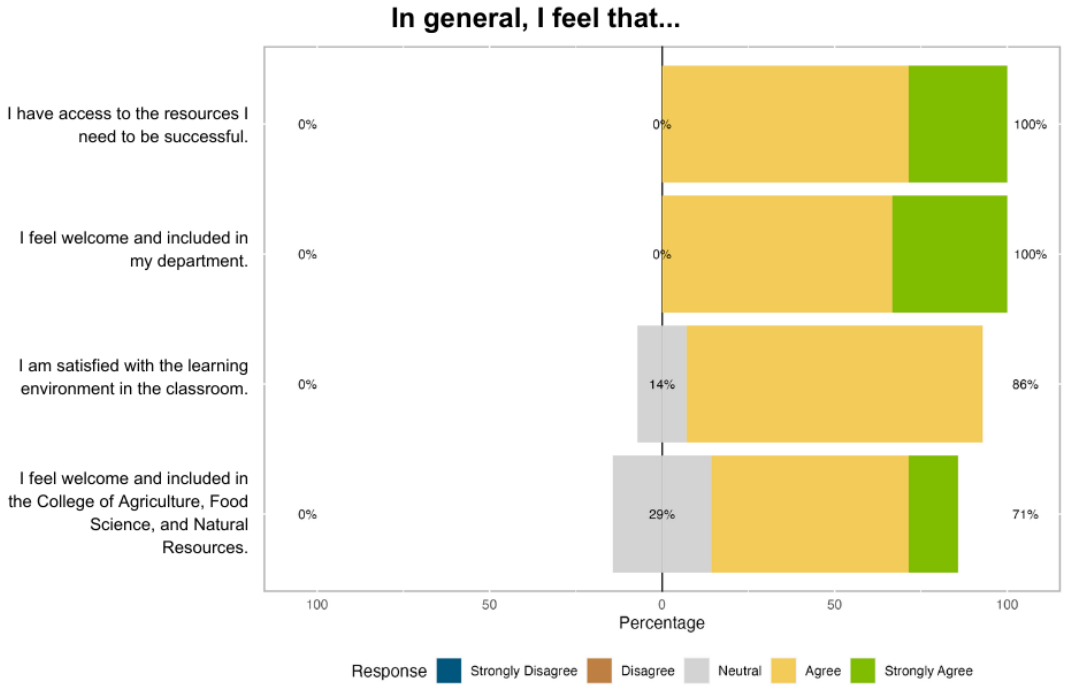

Figure 26. Undergraduate student reflections related to belonging.

When asked about comfortability with members of the department, undergraduate students reported mostly positive findings (Figure 27). 71% of undergraduate students felt

comfortable attending social events in the department, while 14% did not. The same proportions of students felt comfortable seeking feedback and advice from other faculty in the department. 57% of undergraduates feel comfortable disclosing health conditions with their advisor, while 29% do not. The same proportion of students also feel comfortable speaking with their advisor regarding career paths, while 14% do not.

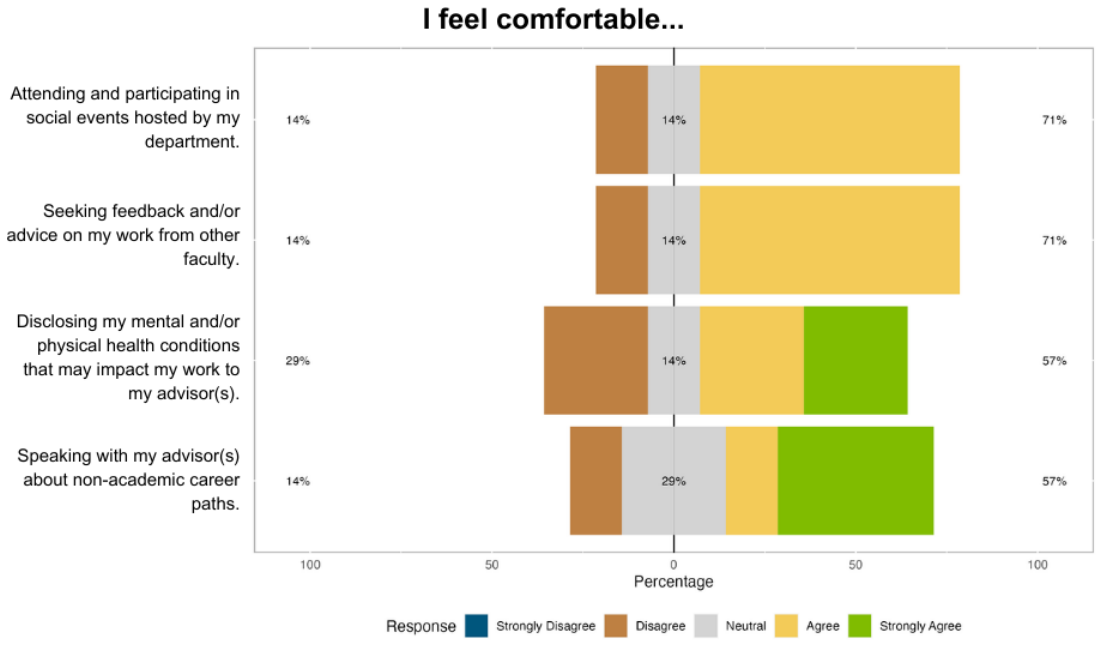

Figure 27. Undergraduate student responses regarding comfortability with department members.

Figure 28 displayed questions regarding interactions with departmental members. Undergraduate students almost unanimously reported positive feelings regarding interactions with peers, advisors, instructors, faculty, and staff within the department.

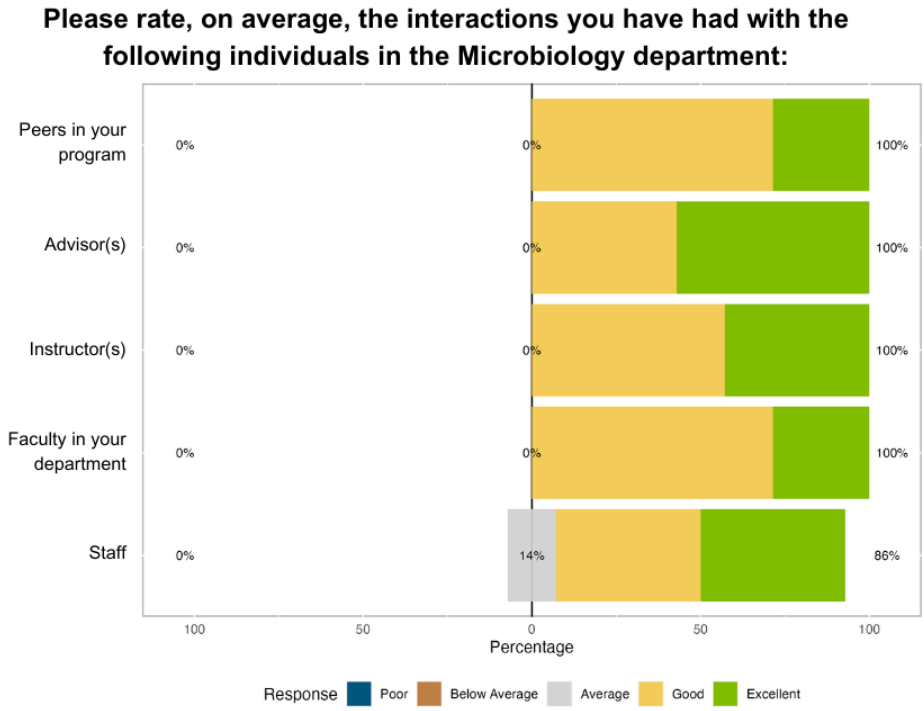

Figure 28. Undergraduate student perceptions of other department members.

Undergraduate students who participate in research within the department were asked questions specific to their research advisor and their skillset (Figure 29). Undergraduate students feel that their research advisor treats their ideas with respect and are available for help with research. Most undergraduates (80%) feel their research advisor provides constrictive feedback and is easy to talk with regarding their research. A somewhat smaller proportion, but still overall positive (60%) of undergraduates feel their research advisor encourages them to present at research conferences.

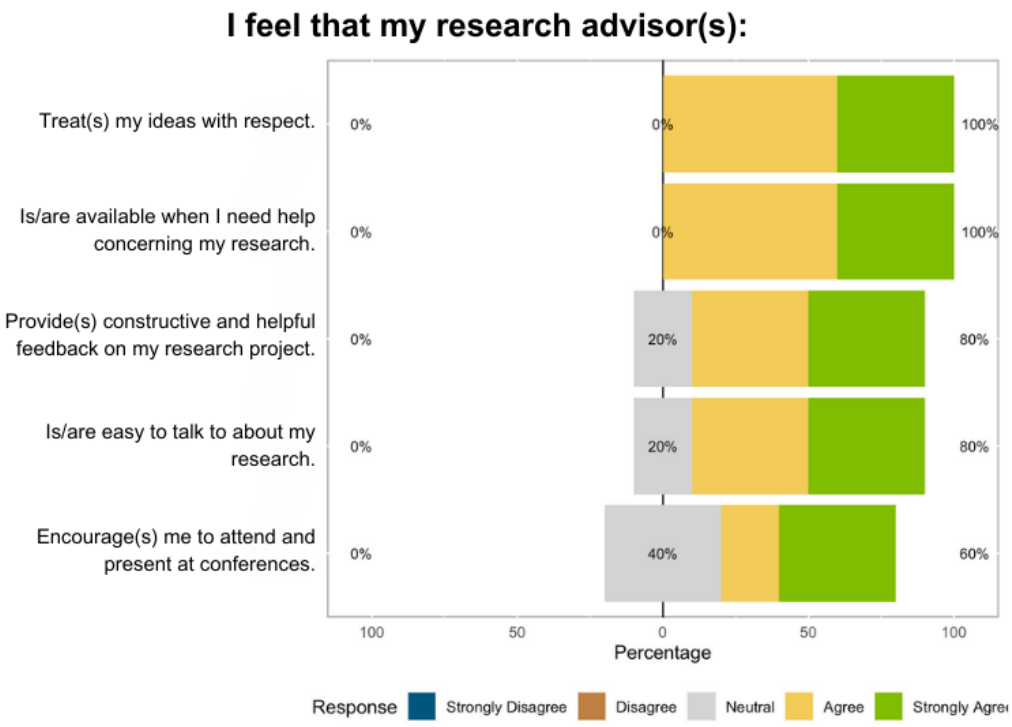

Figure 29. Undergraduate student perceptions of advisor interactions.

Students were asked additional questions of their research advisor, more specific to the relationship and mentorship (Figure 30). 80% of undergraduates feel their research advisor fosters a collaborative laboratory environment, while 20% disagree. Undergraduates feel positively about their research advisor's advocacy and non-research advice, with 80% feeling their research advisor advocates for them and 60% feeling their research advisor provides advice concerning topics other than research. Finally, 60% of undergraduates feel their research advisor provides emotional support when needed, whereas 20% do not.

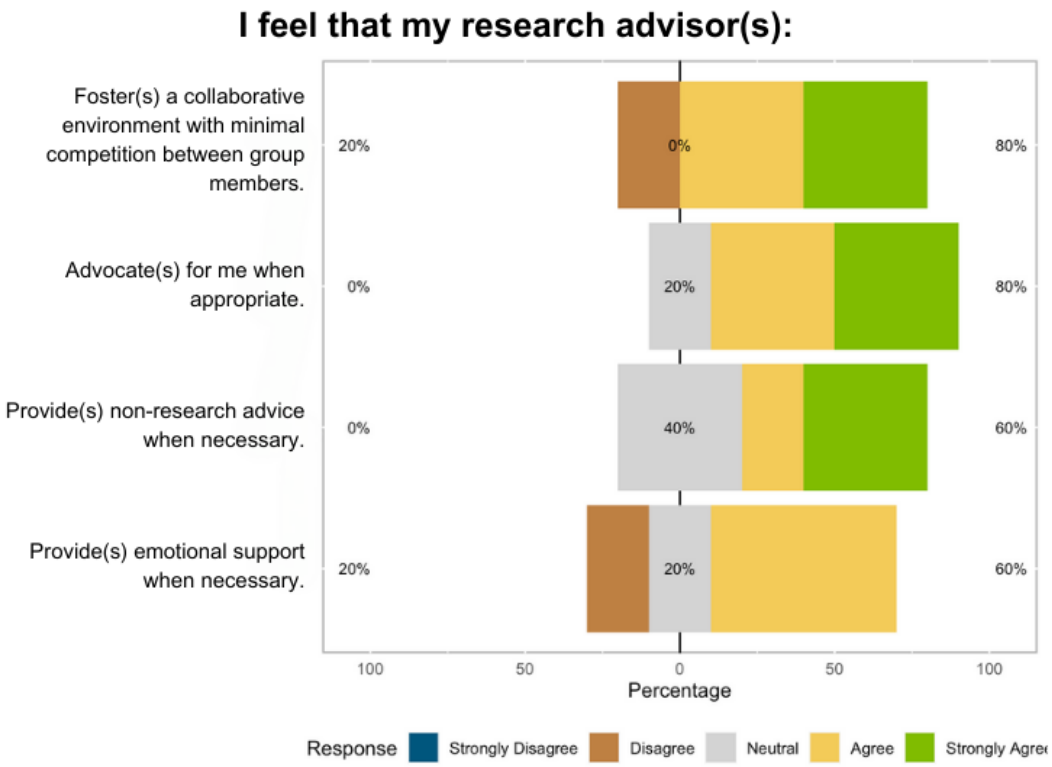

Figure 30. Undergraduate student perceptions of research advisor mentorship.

Undergraduate students who participate in research were also asked questions related to academic publications (Figure 31). All undergraduate researchers agreed that publication impact is more important than quantity of publications. 20% of undergraduates feel that their advisor uses academic publication as a metric of success, while 80% feel their advisor does not. 40% of undergraduates feel that advisors should not use academic publication as the primary metric of student success, and that it is not a primary metric of their own success.

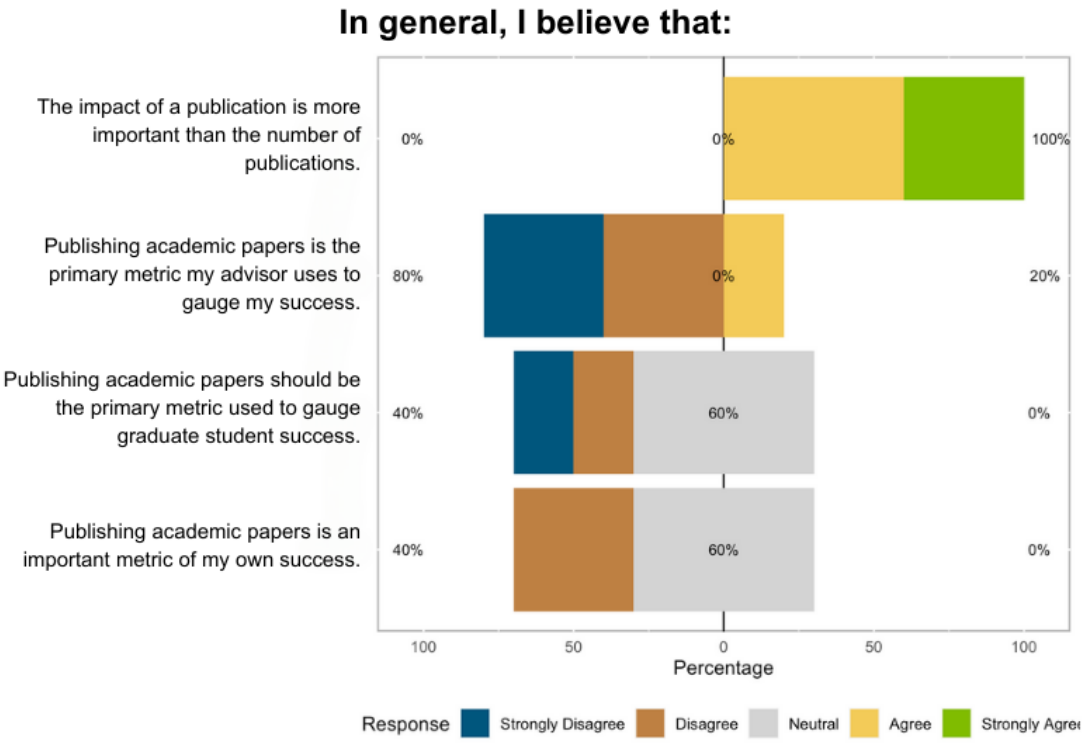

Figure 31. Undergraduate student perceptions on academic publications.

Elaborating on metrics of success, undergraduate students were asked to define what success looks like for their research role. Figure 32 displays the present themes and frequency from qualitative coding of an open-ended question. The most common theme mentioned was to achieve impactful research results.

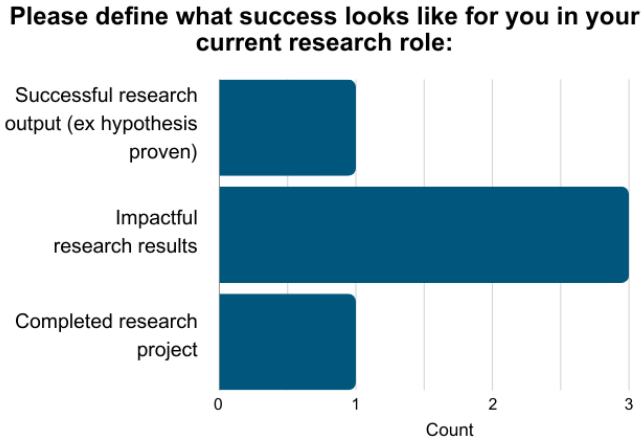

Figure 32. Undergraduate student vision for research success.

Undergraduate students were also asked to discuss what success looks like on a broader scale for their academic and career progression (Figure 33). Degree completion, understanding and applying knowledge, notable achievements (such as high GPA), and acquiring skills for career were mentioned, with skill acquisition being the most common.

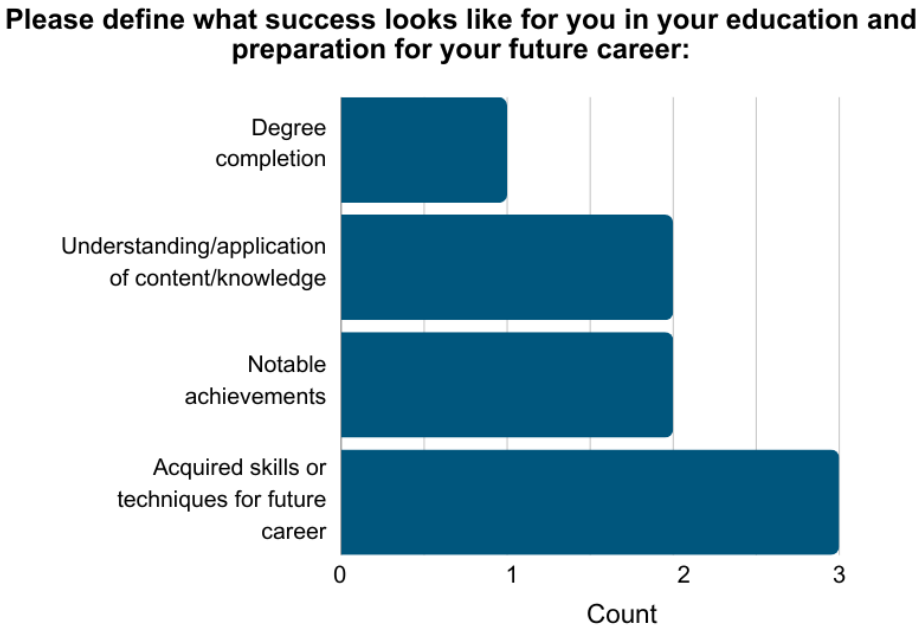

Figure 33. Undergraduate student vision for education and career success.

Undergraduate students were asked to rate the quality of teaching they experienced in the Department of Microbiological Sciences, along with qualitative responses (Figure 34). Although undergraduate students take classes outside of the department for the fulfillment of their degree, the question asked them specifically about the quality of courses in the Department of Microbiological Sciences. The average response was 7.8, with a mode of 7, resulting in an above average quality (average is 5). Undergraduates were able to provide reasonings for their rankings. Undergraduates commented positively on the pedagogy, classroom environment and experience, and course structure/expectations as suitable for learning. However, some students

commented negatively on the classroom environment, as well as negative comments related to the instructor's engagement as a teacher.

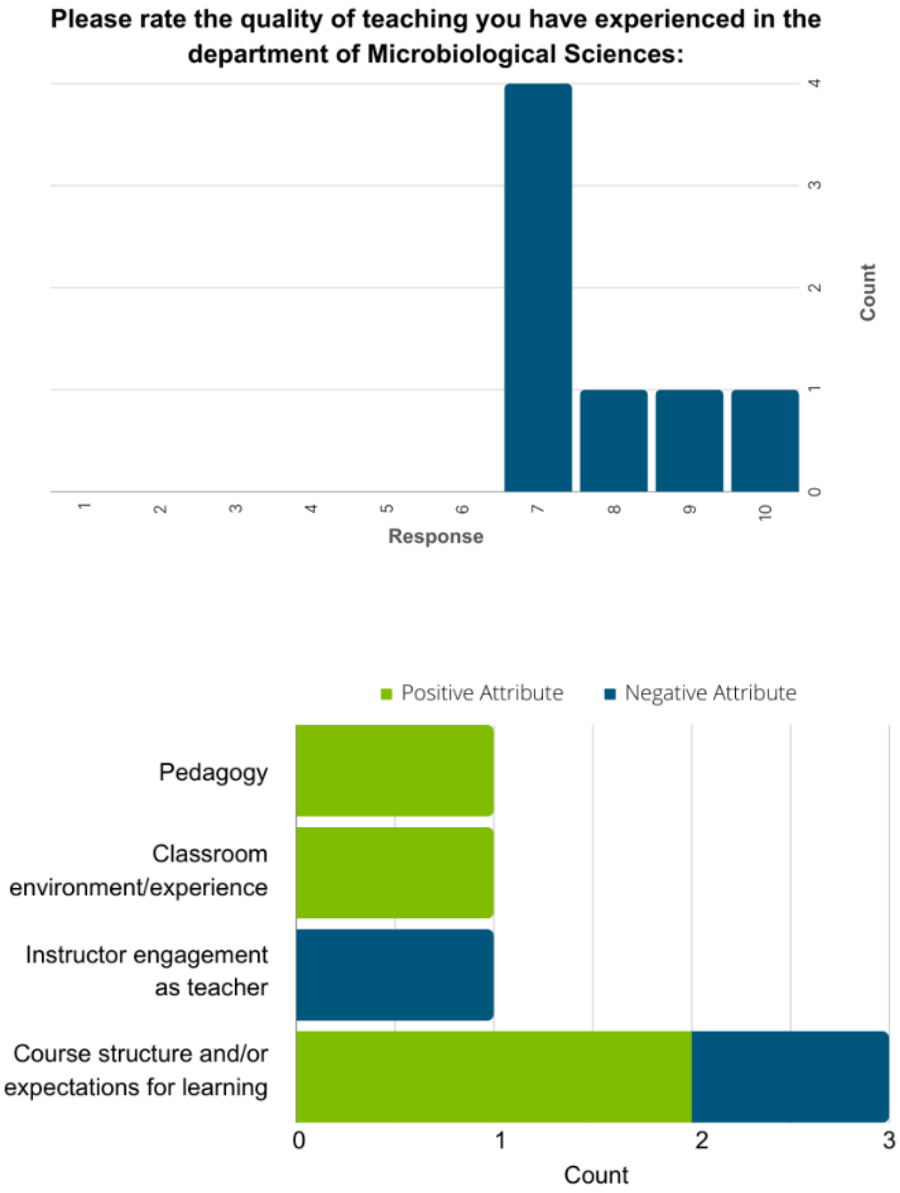

Figure 34. Undergraduate student view of teaching quality.
Left: quantitative response in regard to quality of teaching in the Department of Microbiological Sciences, on a scale of 1 (Poor) to 10 (Excellent). Right: qualitative responses to the question "Please explain your reasoning for your ranking."

Undergraduate students were also asked to rate their school-life balance and provide an explanation (Figure 35). These responses had an average of 5.6, with 5 and 7 being the most common response. Qualitative responses regarding these rankings from undergraduates were collected. Those who felt they had a more consistent balance commented on the ability to manage course or lab work. Undergraduates who felt they had a more inconsistent balance mentioned demanding expectations, work superseding personal time, and course/lab work being ubiquitous, with the latter being the most common theme observed.

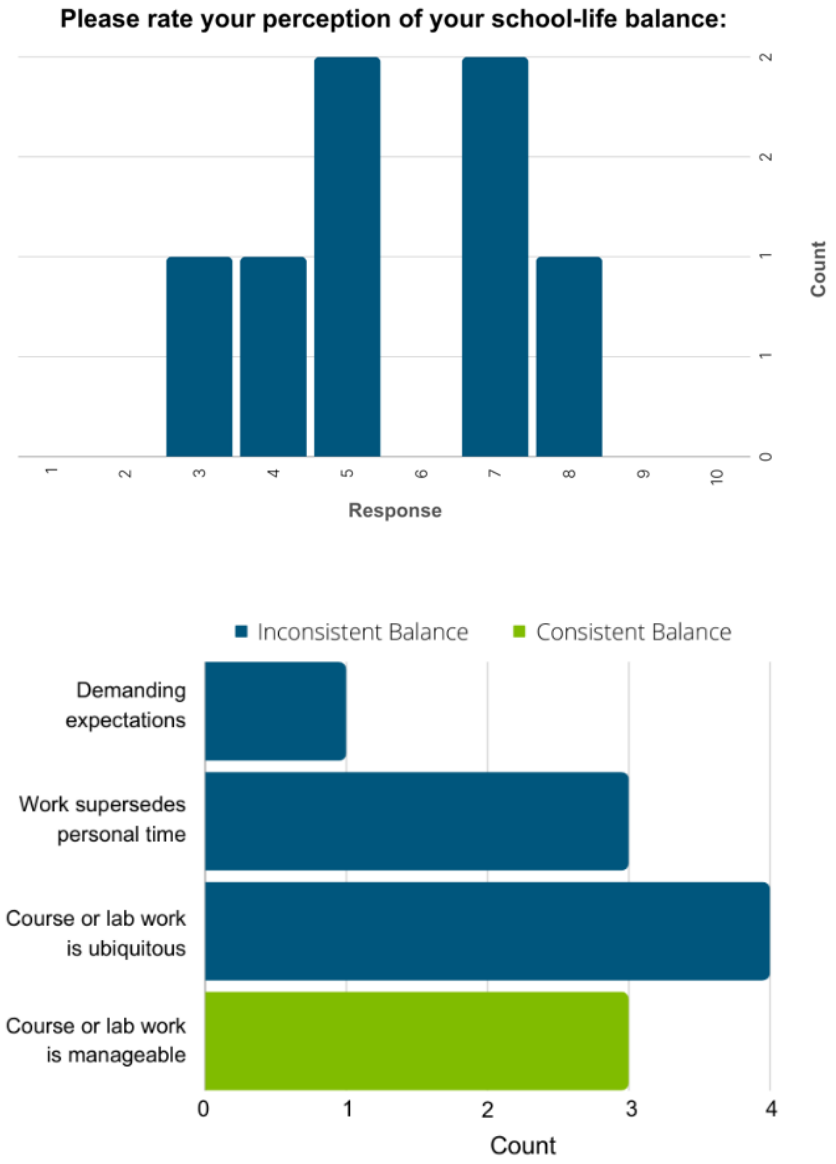

Figure 35. Undergraduate student view of school-life balance.
Left: quantitative response in regard to school-life balance on a scale of 1 (Poor) to 10 (Excellent). Right: qualitative responses to the question "Please explain your reasoning for your ranking."

Students were asked to report their opinion regarding the department environment, with questions specific to behavior (Figure 36). 100% of undergraduates feel that harassment and exclusionary or offensive behavior is not tolerated. Regarding equity and inclusion, 86% of

undergraduates feel there is sufficient action, and 71% feel there is sufficient discussion of equity and inclusion in the department.

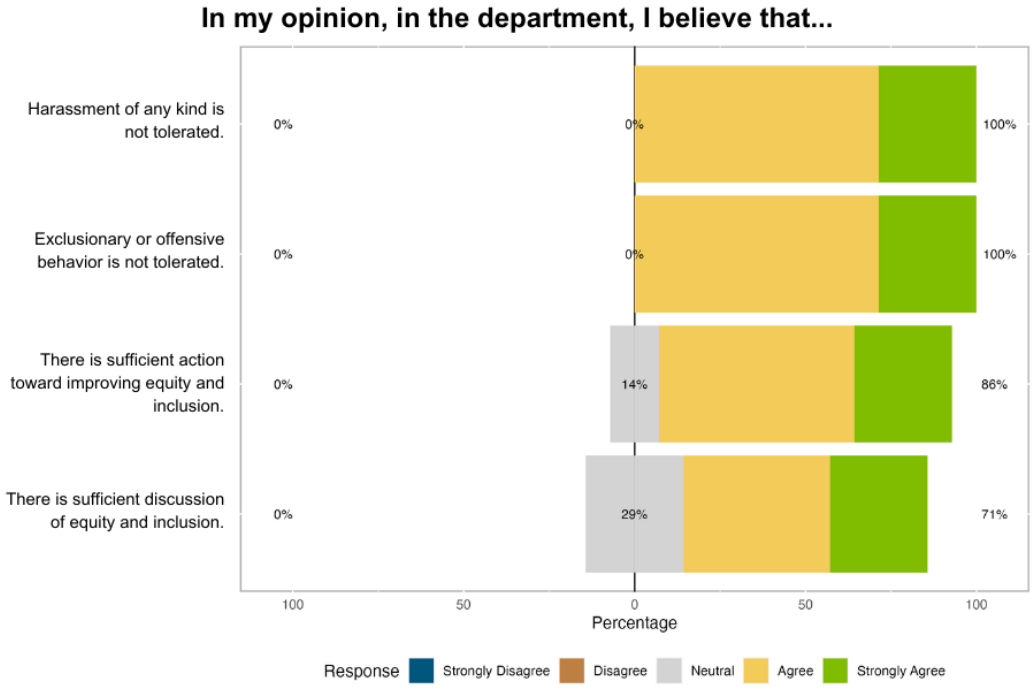

Figure 36. Undergraduate student perception of department environment.

Additional questions were asked regarding equity and inclusion (Figure 37). 86% of undergraduates feel that faculty other than their advisor are available for advice, while 14% do not. These questions were asked for all undergraduates, regardless of research participation, and so advisor may refer to their academic or research advisor. With regards to departmental climate and inclusion, 71% of undergraduates feel they are included in the department, and they know who to discuss climate concerns. Additionally, the same proportion of undergraduates feel that members of the department who identify as minorities are valued and included.

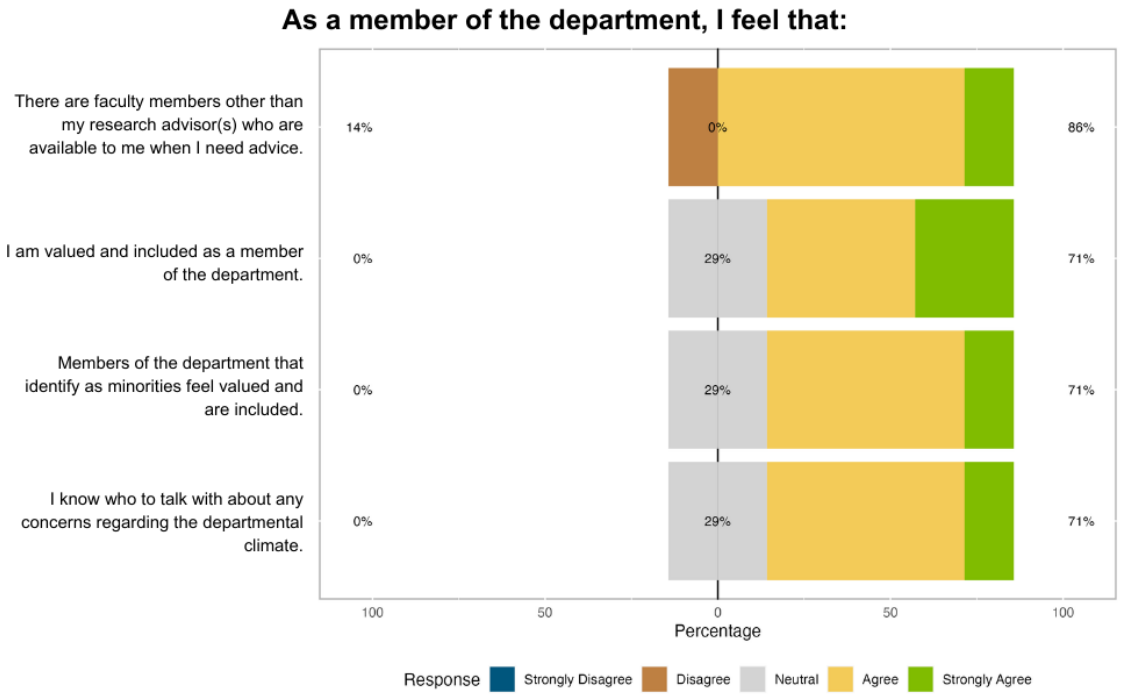

Figure 37. Undergraduate student perception of equity and inclusion

Finally, undergraduate students were asked to respond to questions specific to URG members (Figure 38). 57% of undergraduates regarded educating department members about biases and behaviors as very important, and 29% felt this was somewhat important. 29% of undergraduates feel that increasing retention of students from URGs is very important, and 57% feel it is somewhat important. Finally, 14% of undergraduates feel educating department members about representation and compensation of URG members is very important, and 71% feel this is somewhat important. However, 14% of undergraduates felt all three of these were not important.

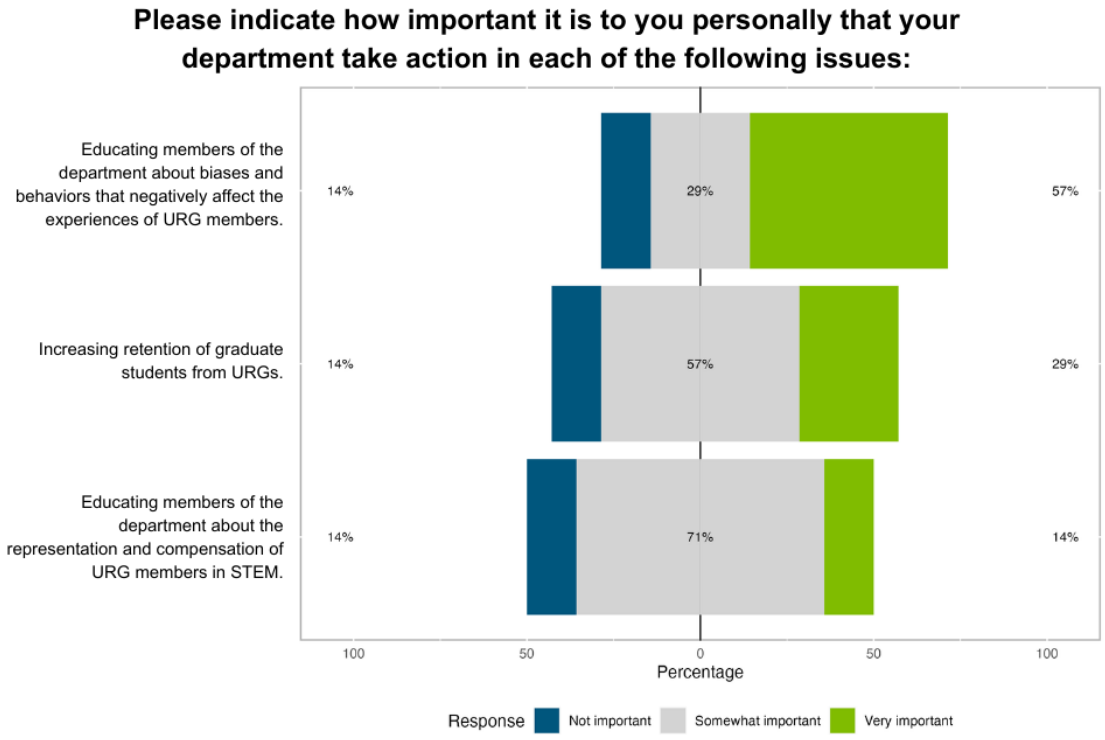

Figure 38. Undergraduate perceptions with regards to URG members.

Graduate students

Graduate students were asked questions related to their belonging, efficacy, and learning environment experience (Figure 39). Almost all graduate students (94%) feel welcome and included in the department. 88% of graduate students feel they have access to resources needed for success, while 6% do not. In terms of feeling welcome and included in their academic college (CAFSNR), 67% of graduate students agreed to feeling welcome, while 6% disagreed. Finally, 67% of graduate students feel satisfied with their learning environment, while 13% do not.

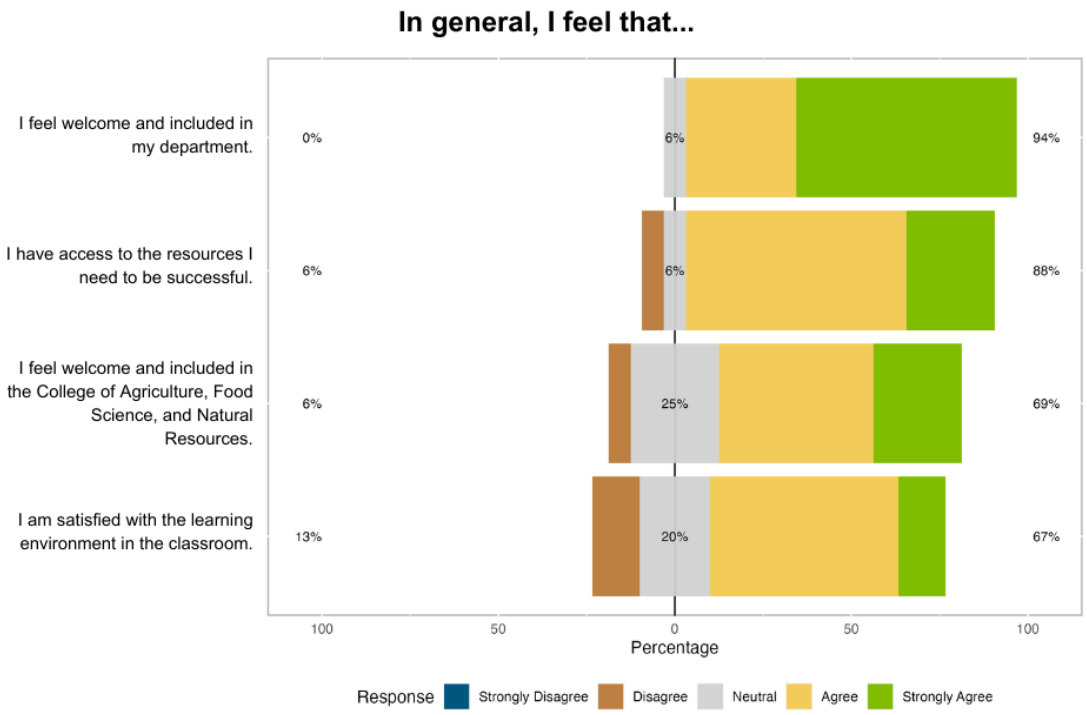

Figure 39. Graduate student reflections related to belonging.

Graduate students were asked questions related to department experiences or members (Figure 40). With reference to attending social events in the department, 88% of graduate students feel comfortable doing so, while 6% do not. Additionally, in the same proportions, 88% of graduate students feel comfortable seeking feedback from other faculty, while 6% do not. In regard to their advisor, 56% of graduate students feel comfortable discussing non-academic careers with their advisors, while 44% do not. In addition, 50% of graduate students feel comfortable disclosing health concerns that may impact their work with their advisor, while 38% do not.

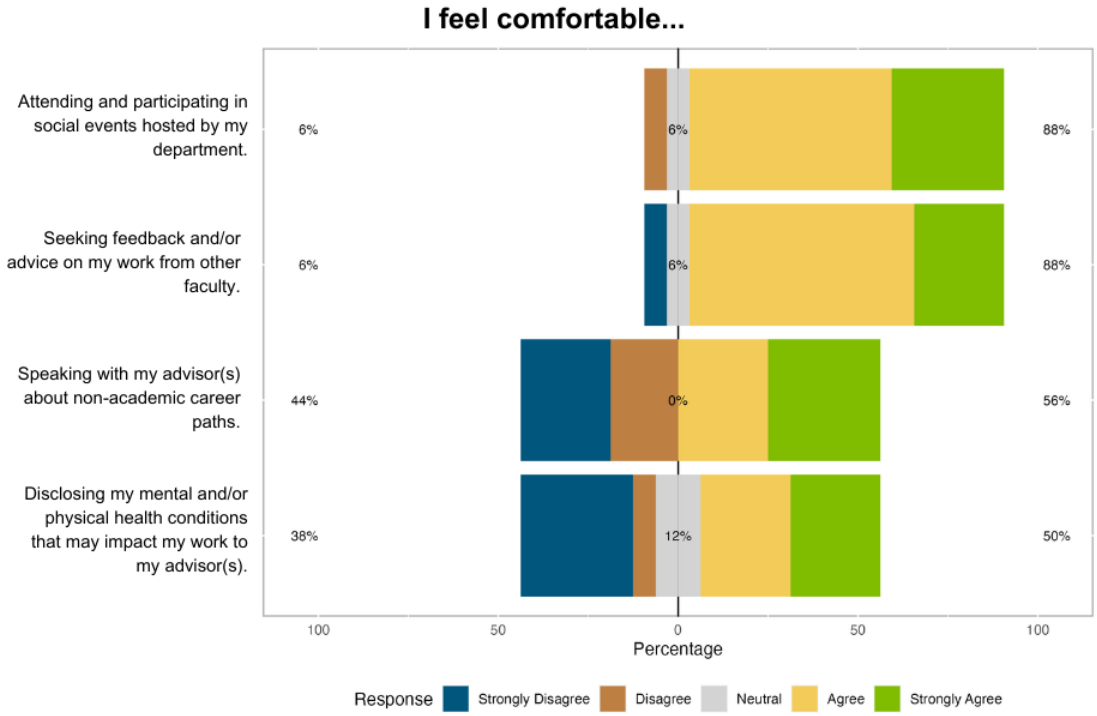

Figure 40. Graduate responses regarding comfortability with department members.

Graduate students were also asked to rate their interactions with other members of the department (Figure 41). Graduate students rated interactions with staff, instructors, and their peers positively (88% each). With a slightly smaller proportion, 81% of graduate students feel positively about faculty in the department. Finally, 56% of graduate students rated interactions with their advisor positively, while 25% of graduate students rated their interactions negatively.

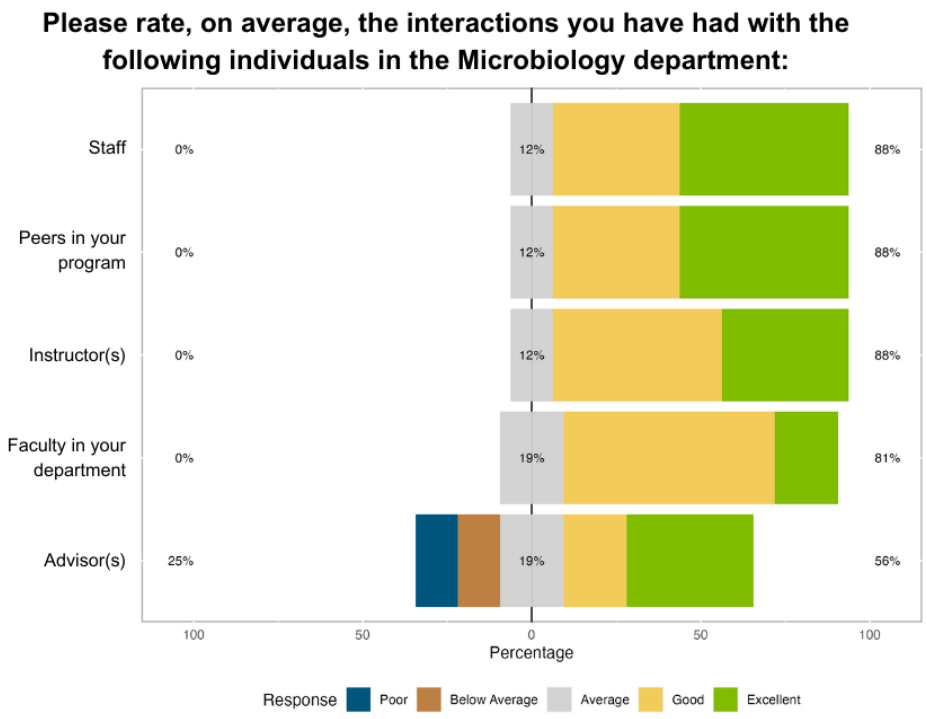

Figure 41. Graduate perceptions of other department members.

Expanding on their advisor interactions, graduate students were asked more questions related to advisor skill, and results are displayed in Figure 42. 86% of graduate students feel their advisor is easy to talk to about research, while 7% feel the opposite. Majority of graduate students (86%) feel their advisor encourages them to present at conferences. While 71% of graduate students feel their advisor is available for help concerning their research, 21% feel they are not. Finally, 64% of graduate students feel their advisor treats their ideas with respect and provides constructive feedback on their research project. However, some graduate students disagree, with 29% and 14% feeling the opposite, respectively.

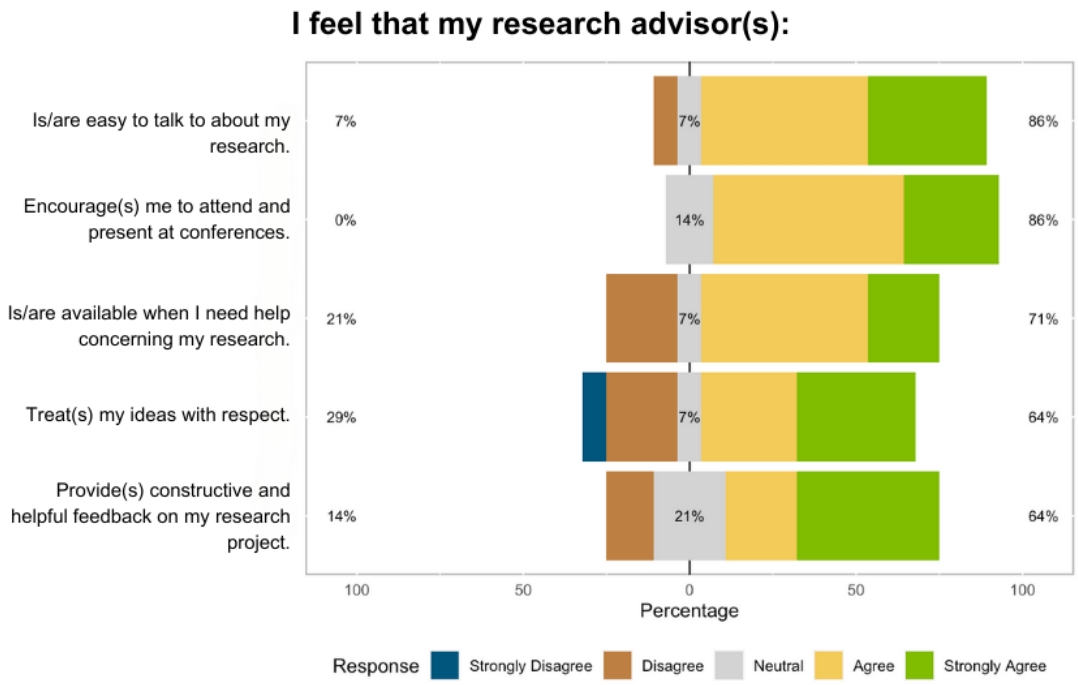

Figure 42. Graduate student perceptions of advisor interactions.

Figure 43 shows extended questions of graduate student perceptions of their advisors, with a larger focus on mentorship. While 71% of graduate students feel their advisor advocates for them, 21% feel their advisor does not. Additionally, 50% of graduate students feel their advisor provides emotional support and fosters a collaborative environment in the lab. However, 36% of graduate students disagree and feel the opposite. Finally, while the same proportion (36%) of graduate students feel their research advisor does not provide non-research advice, 43% of graduate students feel as though their advisor does.

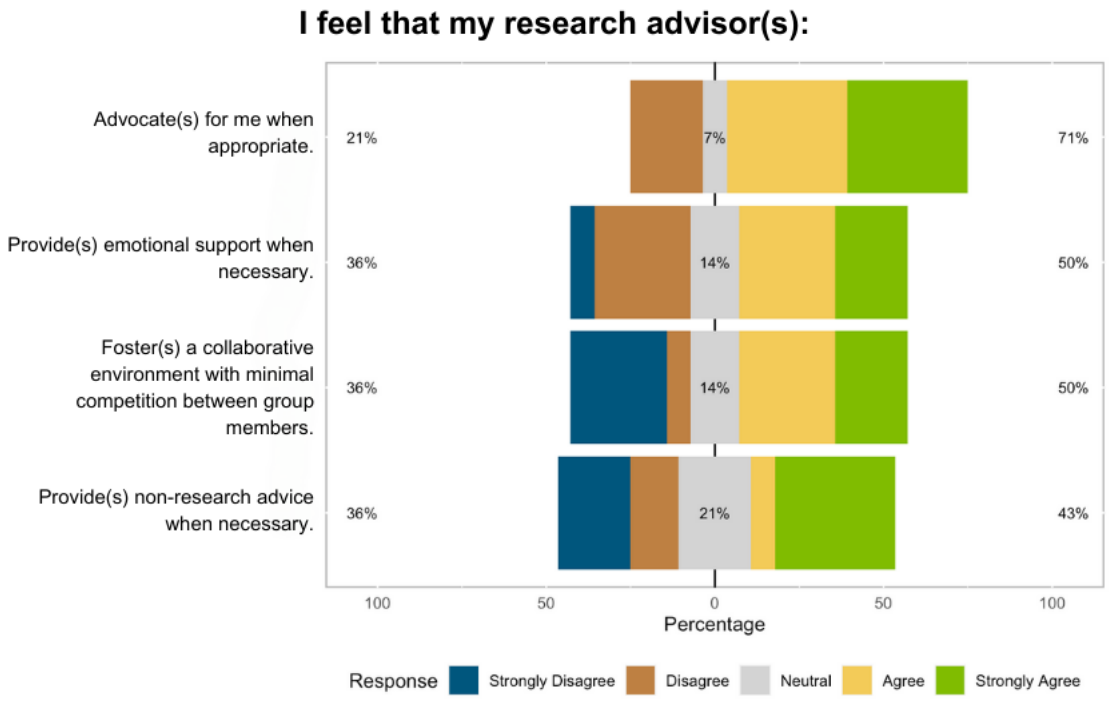

Figure 43. Graduate student perceptions of research advisor mentorship.

Graduate students were asked questions regarding academic publications (Figure 44). The majority of graduate students (79%) believe that publishing academic papers is an important metric of their success. Despite this, only 21% of graduate students feel that it should be a primary metric of their success, while 64% of graduate students feel it should not be their primary success metric. 64% of graduate students agree that publishing is the primary metric their advisor uses to gauge their success, while 29% of students disagree. Finally, 71% of graduate students feel publication impact is more important than quantity of publications, whereas 14% feel that quantity is more important.

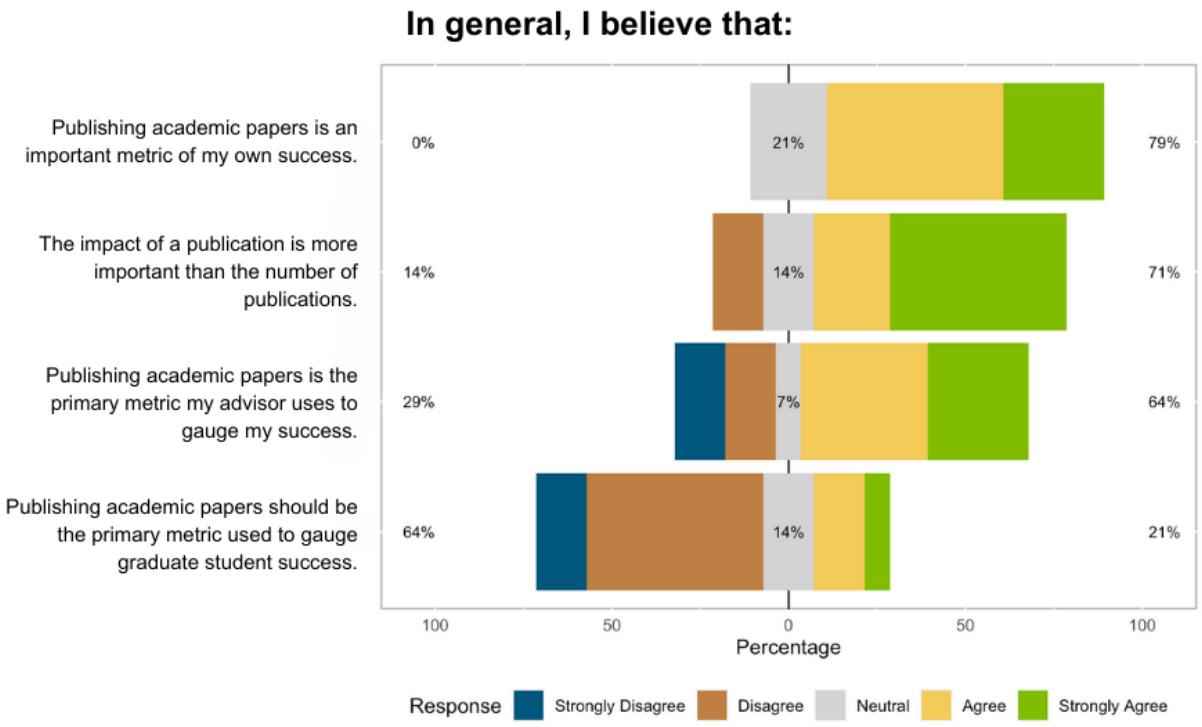

Figure 44. Graduate student perceptions on academic publications.

After discussing publications as a metric of success, graduate students were asked to define success in their research roles (Figure 45). Themes identified included impactful research results, completing a research project, meeting goals and outcomes, and consistent progress. The most common theme was meeting goals and achieving personal outcomes.

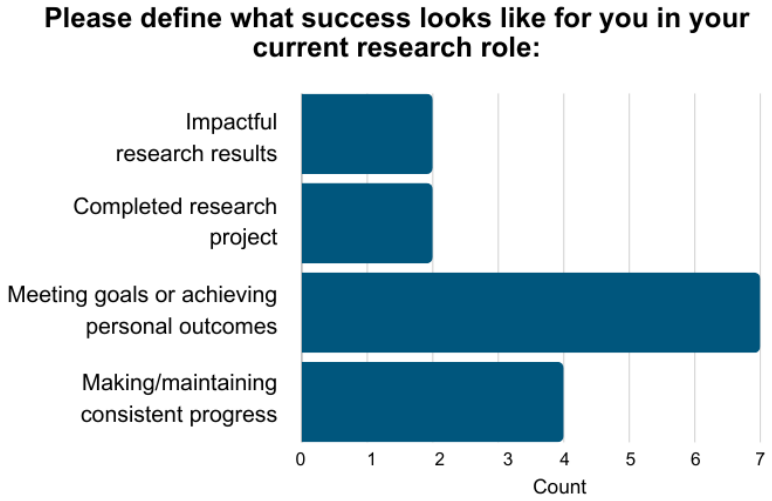

Figure 45. Graduate student vision for success in research.

Following success in research roles, graduate students were asked to elaborate their vision for success in academics and preparation for their future career. Themes and frequency are identified in Figure 46. Degree completion, applying knowledge, acquiring techniques, and building a network are among the more frequent themes.

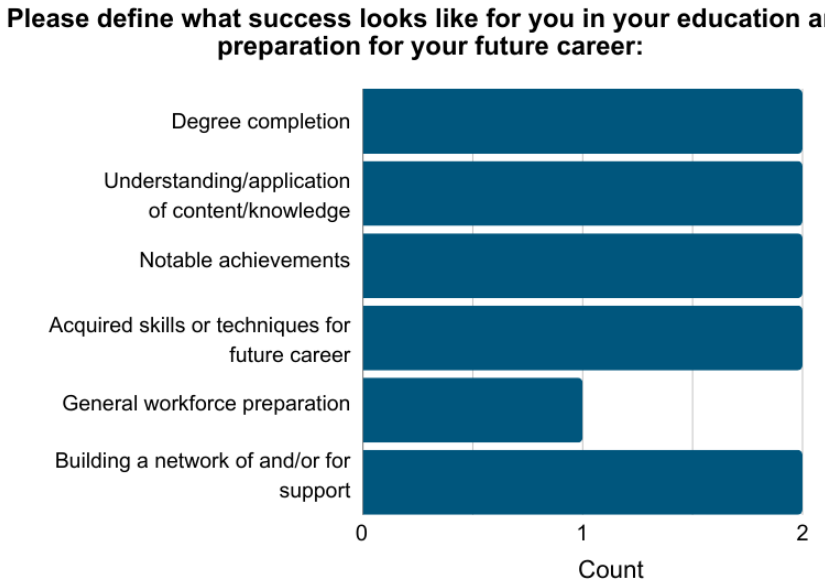

Figure 46. Graduate student vision for success in education and career preparation.

Graduate students were asked to rate the teaching quality they have experienced in the Department of Microbiological Sciences, as well as report their reasoning for their ratings (Figure 47). Some graduate students may take classes outside of the department for the fulfillment of their degree, but this question was phrased to gain an understanding of teaching quality specific to the Department of Microbiology. The average rating was 7.9 with a mode of 8, resulting in an above-average rating (average is 5). When asked to report themes, graduate students mentioned positive comments related to pedagogy (n=4), instructor being engaged in teaching (n=5), and the course structure and expectations being suitable for learning (n=2). Negative attributes were mentioned for all three themes as well, with negative views of pedagogy (n=1), instructor not being engaged as a teacher (n=4), and course structure/expectations not suitable for learning (n=2). Instructor engagement was the most common theme for positive and negative attributes.

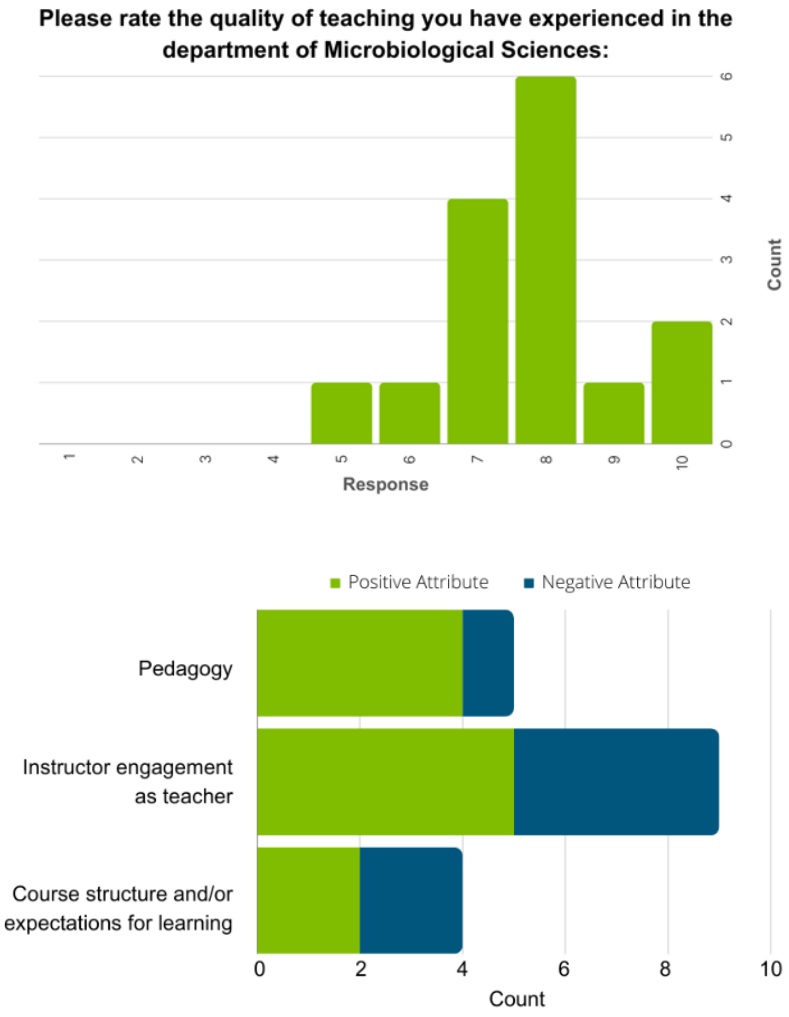

Figure 47. Graduate student perceptions of teaching quality.
Left: quantitative response in regard to quality of teaching in the Department of Microbiological Sciences, on a scale of 1 (Poor) to 10 (Excellent). Right: qualitative responses to the question "Please explain your reasoning for your ranking."

Graduate students also rated their school-life balance, as well as provided qualitative comments that influenced their rating. Graduate students had an average balance rating of 5.6, which is slightly above average (average being 5). Respondents who have a more consistent balance commented on their ability to disconnect from work or school and being able to manage their course or lab work. Of those graduate students who discussed a more inconsistent balance,

a lack of routine was mentioned (n=1), but common themes discussed were demanding expectations (n=3), and that work superseded personal time (n=6).

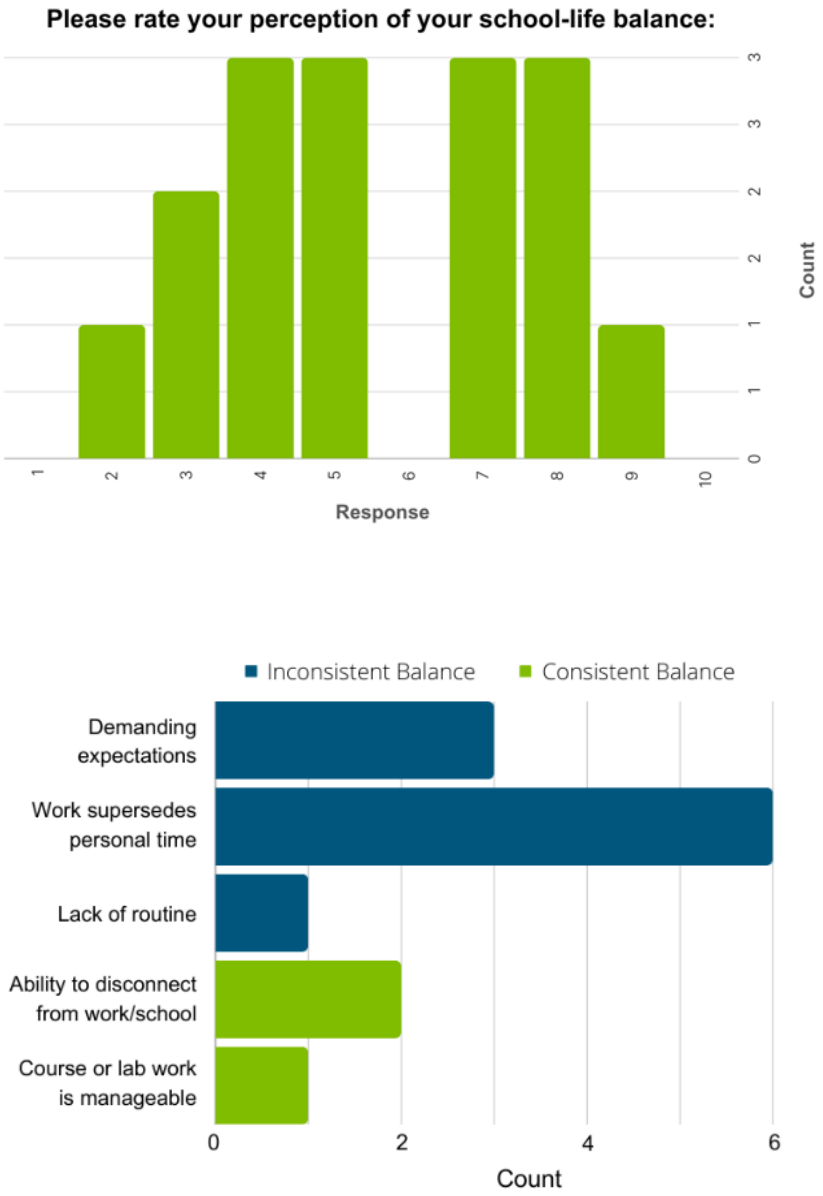

Figure 48. Graduate student perceptions of school-life balance.
Left: quantitative response in regard to school-life balance on a scale of 1 (Poor) to 10 (Excellent). Right: qualitative responses to the question "Please explain your reasoning for your ranking."

Figure 49 shows graduate student responses to questions regarding department climate. 94% of respondents feel that harassment, and exclusionary or offensive behavior is not tolerated in the department. With regards to equity and inclusion, 69% of students feel there is sufficient department action, and 62% feel there is sufficient discussion concerning equity and inclusion. However, some students disagreed, with 12% feeling there is not sufficient action and 25% feeling there is not sufficient discussion concerning equity and inclusion.

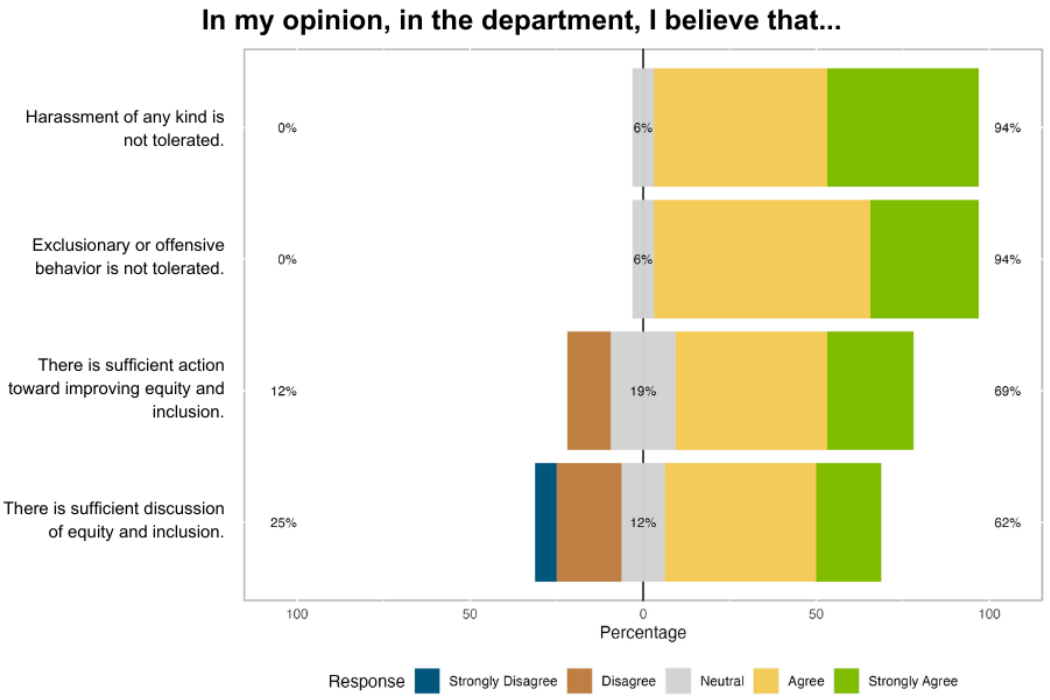

Figure 49. Graduate student perception of department environment.

Further expanding the topic of equity and inclusion, students were asked to reflect on their personal experience (Figure 50). 94% of graduate students feel they know who to talk to regarding department climate concerns, and 81% feel valued as members of the department. 88% of graduate students feel that there are faculty other than their advisors that are available for advice, while 6% disagree. Finally, 81% of graduate students agree that minorities in the department feel valued and included, while 6% disagree.

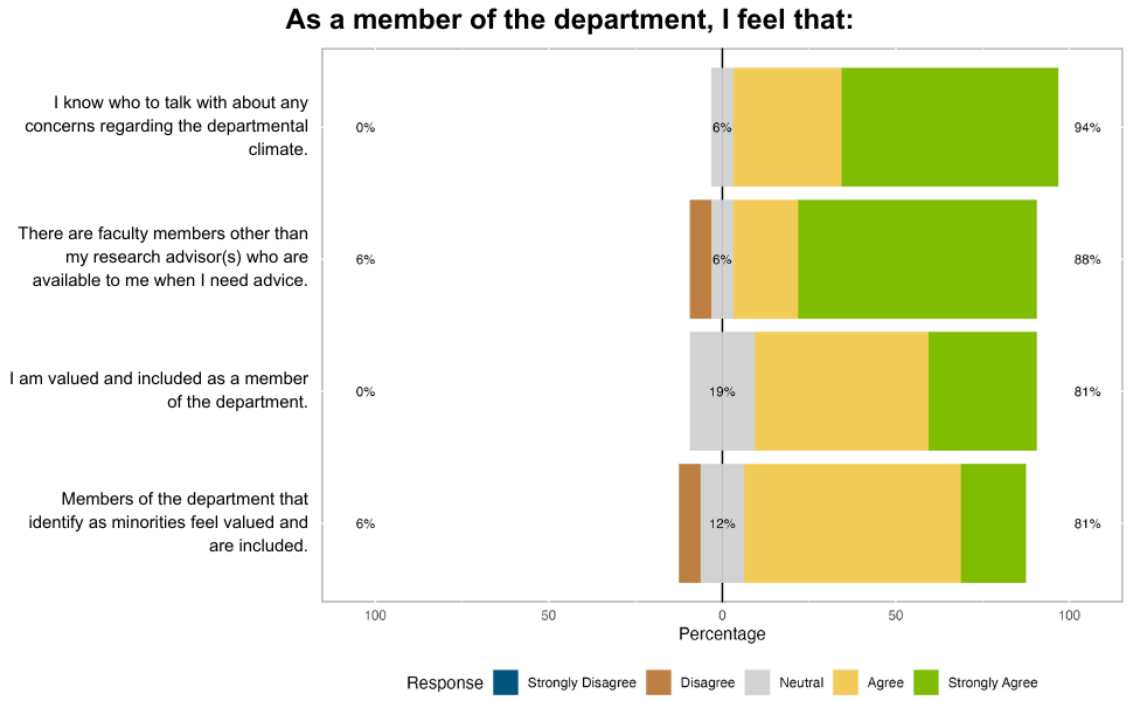

Figure 50. Graduate student perception of equity and inclusion.

Graduate students were also asked questions specifically with regards to URG members (Figure 51). 94% of graduate students feel some level of importance when it comes to educating department members about biases and behaviors that negatively impact URG members and increasing the retention of graduate students from URGs. However, 6% of graduate students disagree and feel these are not important. Additionally, while 88% of graduate students feel it is important to educate department members about URG member compensation and representation, whereas 12% do not feel it is important.

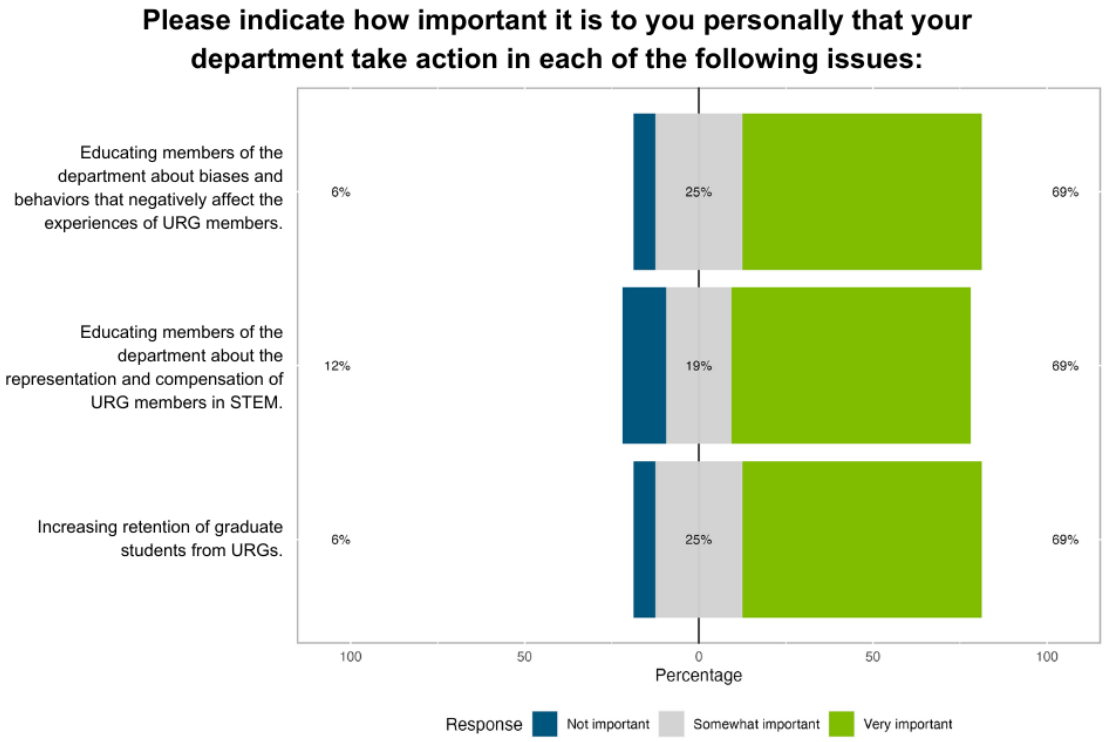

Figure 51. Graduate perceptions with regards to URG members.

Staff

Staff were asked questions aimed at targeting their perceptions of belonging, value, and efficacy (Figure 52). Staff unanimously feel their work schedule is flexible and they have access to resources they need to be successful. Additionally, 80% of staff feel their leaders and managers are transparent, as though they are valued, welcome, and included in the department, and connected to their work. With regards to recognition, 60% of staff feel as though they are recognized for their contributions, while 20% feel as though they are not. Finally, when asked about their academic college (CAFSNR), 60% of staff feel welcome and included, and 40% feel valued. However, while 20% of staff do not feel welcome and included in CAFSNR, and 40% do not feel valued.

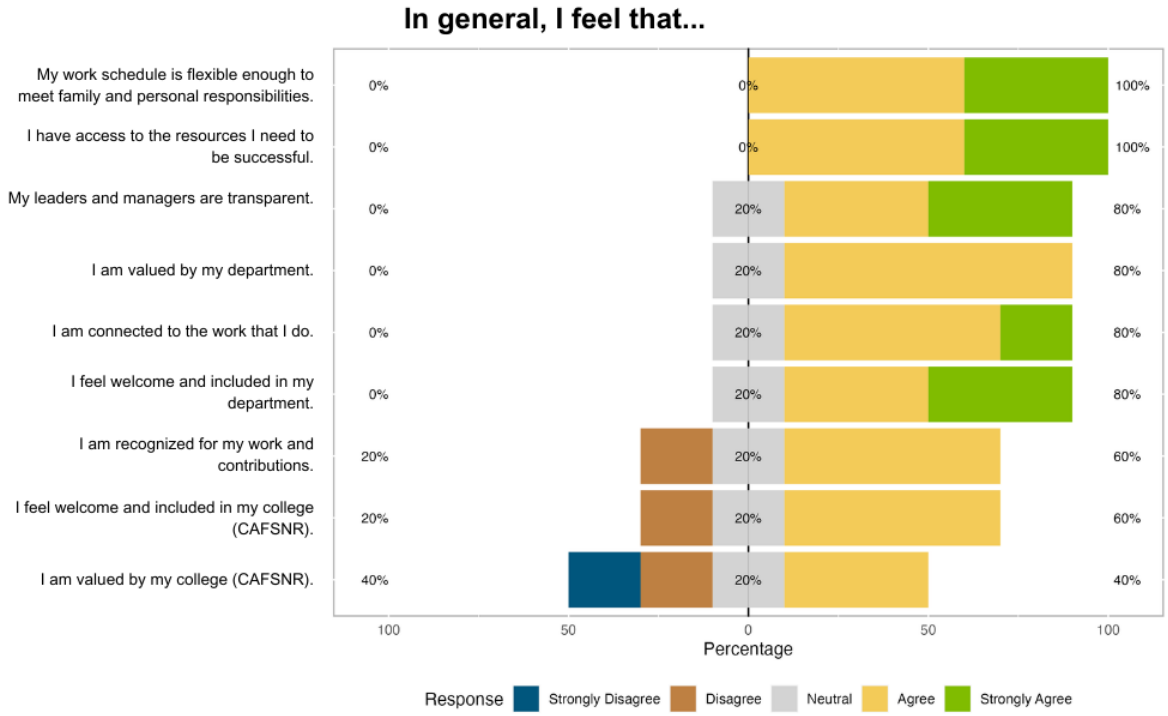

Figure 52. Staff perceptions regarding efficacy, belonging, and value.

Staff were asked questions regarding providing student support (Figure 53). Staff feel positively about the environment they foster between group members, as 60% of staff feel they foster a collaborative environment. 80% of staff agree they are available to their students for advice concerning the student's research. Additionally, 80% of staff feel comfortable directing students to campus resources.

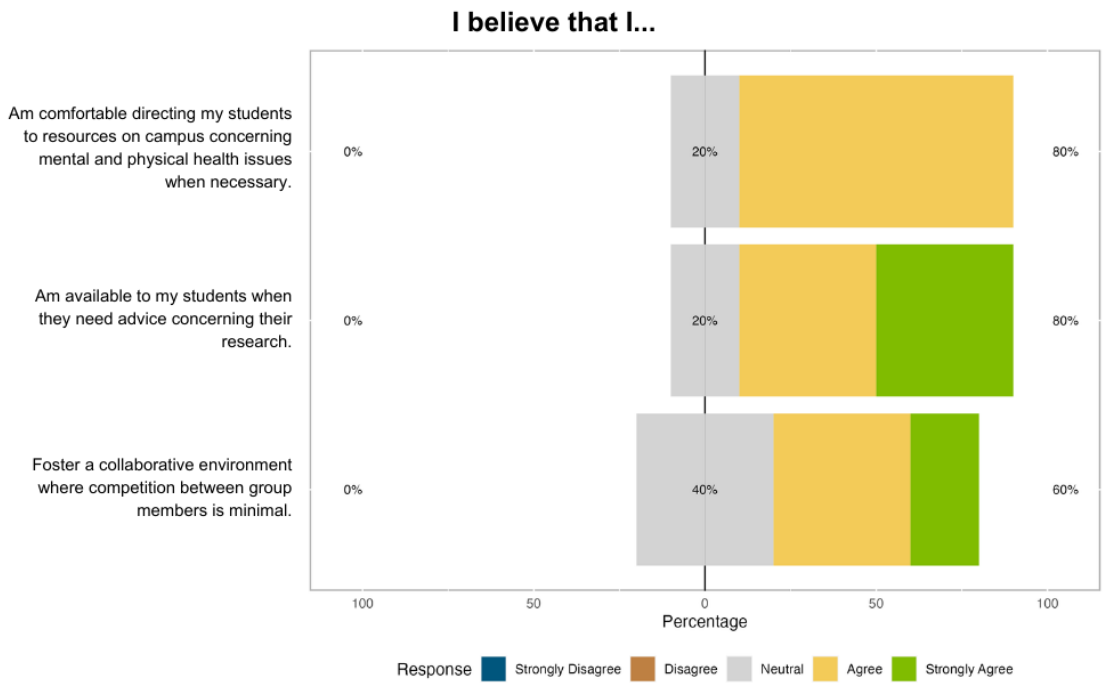

Figure 53. Staff responses regarding student support.

Staff were asked questions specifically about academic publications (Figure 54). 60% of staff agree publication impact is more important than publication quantity. While 20% of staff feel academic publication is an important metric of their success, 40% of staff disagreed. 60% of staff disagreed with the sentiment that academic publication is the primary metric used for student research success.

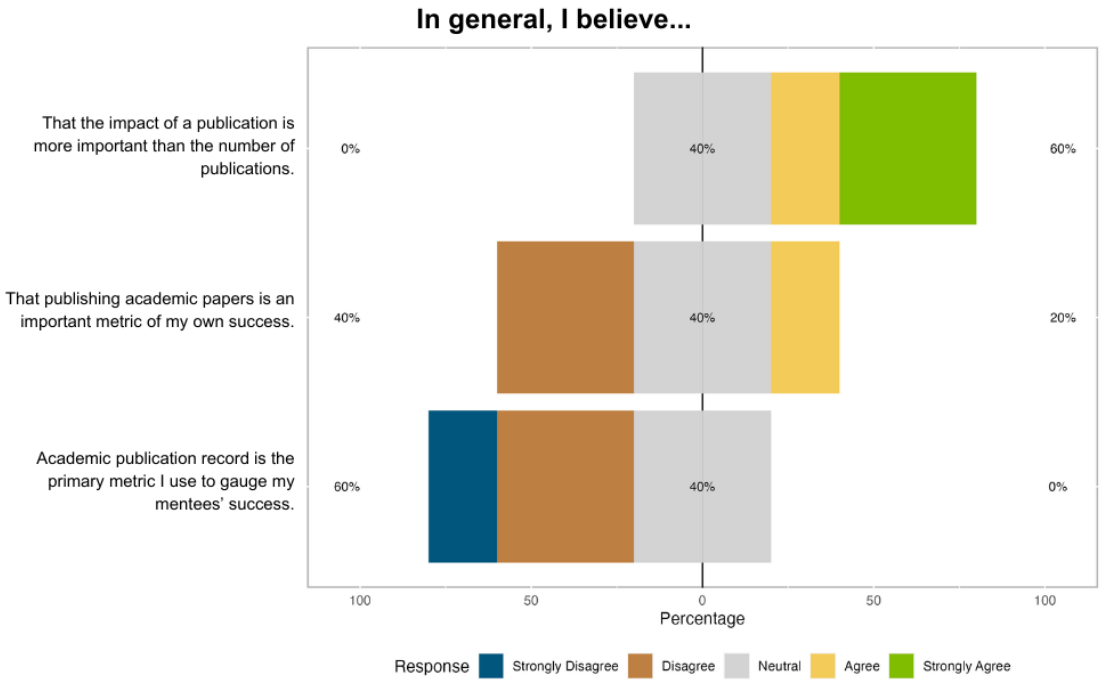

Figure 54. Staff responses to values regarding academic publications.

Following academic publications as a potential success metric, staff were asked to summarize what metrics they used to gauge their research student success. Figure 55 displays the themes and frequency observed. Staff commented on student learning, contributing to their field, and preparation for future as success metrics for their students.

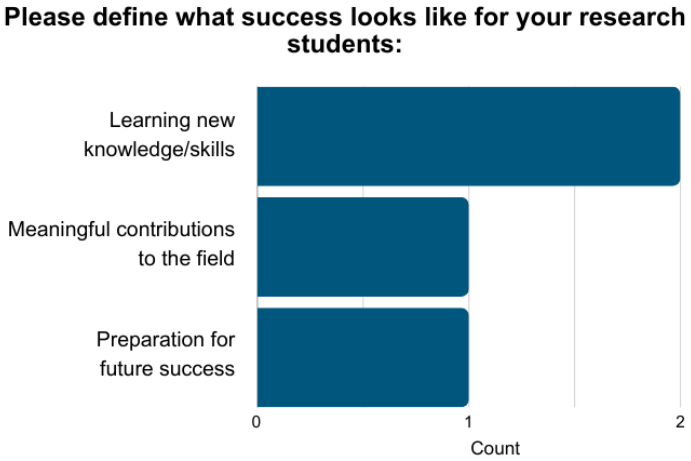

Figure 55. Staff responses for research student success metrics.

Staff were also asked to identify metrics used for gauging their own success (Figure 56). Staff mentioned meeting deadlines and maintaining productivity, having positive contributions, and being satisfied with their work as success metrics.

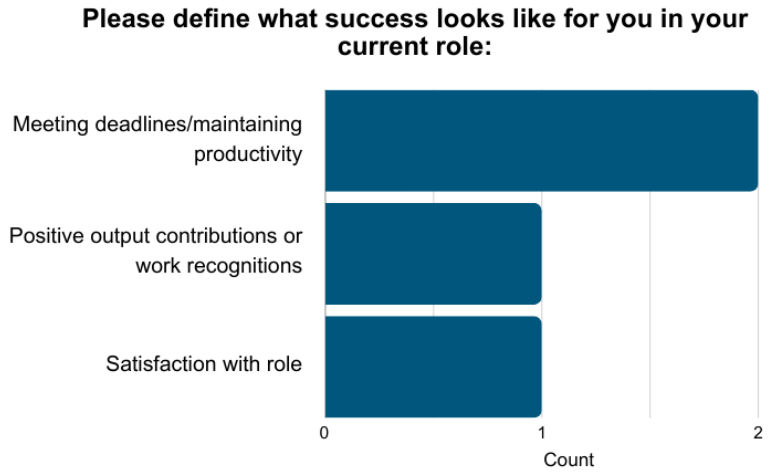

Figure 56. Staff responses regarding personal success metrics.

Staff were asked questions specific to their interactions with department colleagues, and their responses are reported in Figure 57. All staff feel comfortable seeking feedback or advice from their colleagues, and 80% of staff agree that faculty members cooperate and collaborate. While 60% of staff agree there is a mutual sense of respect between faculty, 20% disagree.

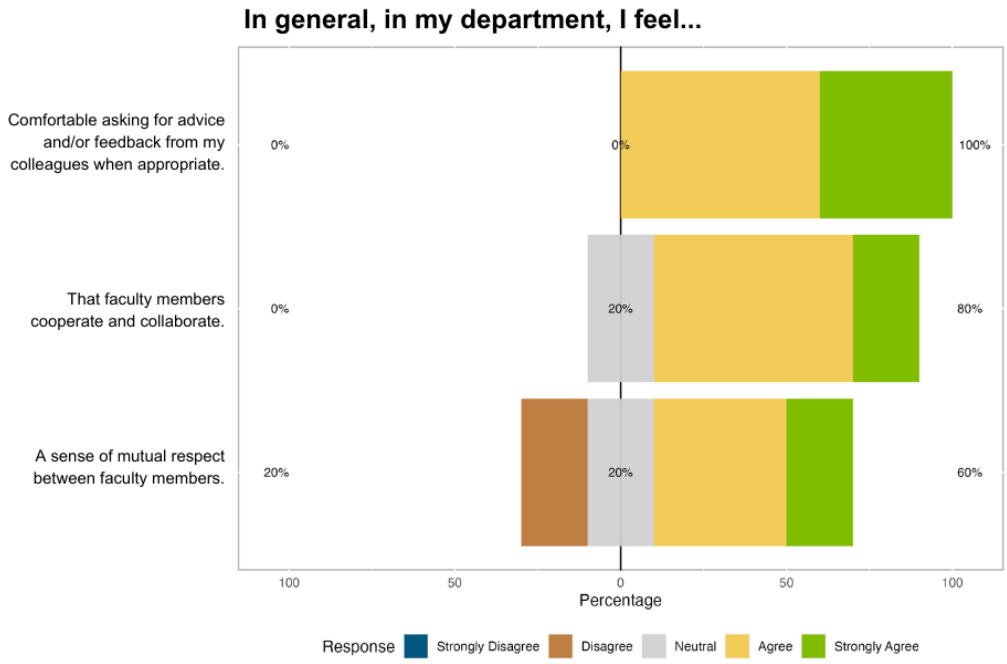

Figure 57. Staff responses regarding department colleagues.

Staff were asked questions related to behavior within the department and equity and inclusion (Figure 58). While 80% of staff agree that harassment and exclusionary or offensive behavior is not tolerated in the department, 20% disagree. Additionally, 60% of staff agree that sufficient discussion and action of equity and inclusion.

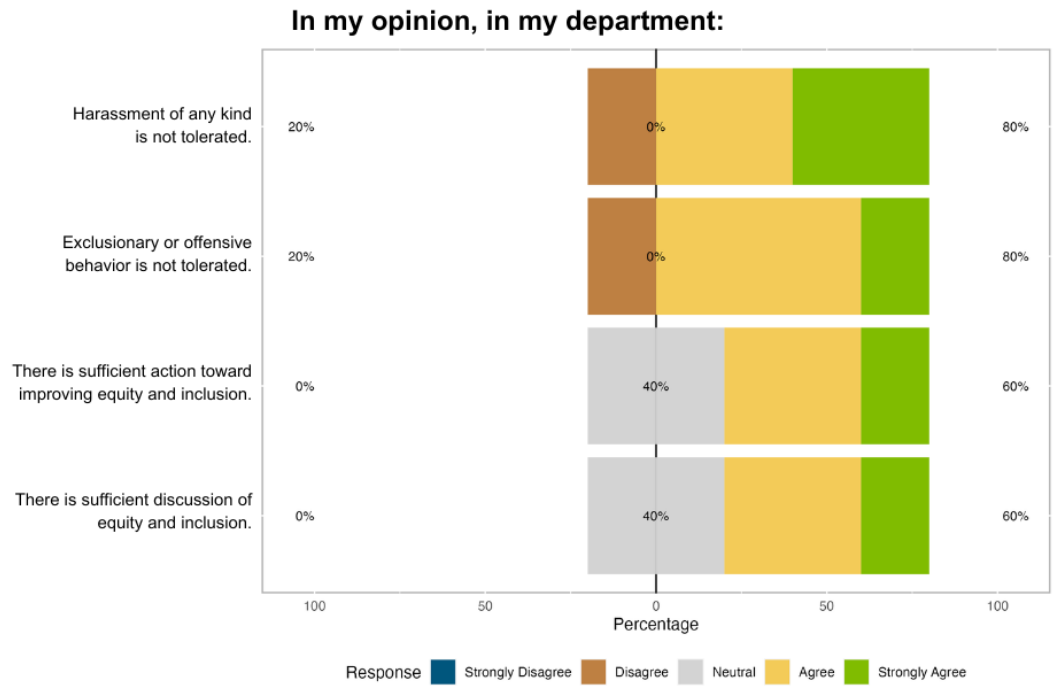

Figure 58. Staff responses regarding behavior and inclusion.

Figure 59 displays staff responses to questions specific to the climate in the department. 80% of staff agree they know who to talk with concerning the department climate, while 20% disagree. Additionally, in the same proportions, 80% of staff feel that members of all cultures/backgrounds are respected and valued, while 20% disagree. Finally, 80% of staff members feel valued and included in the department.

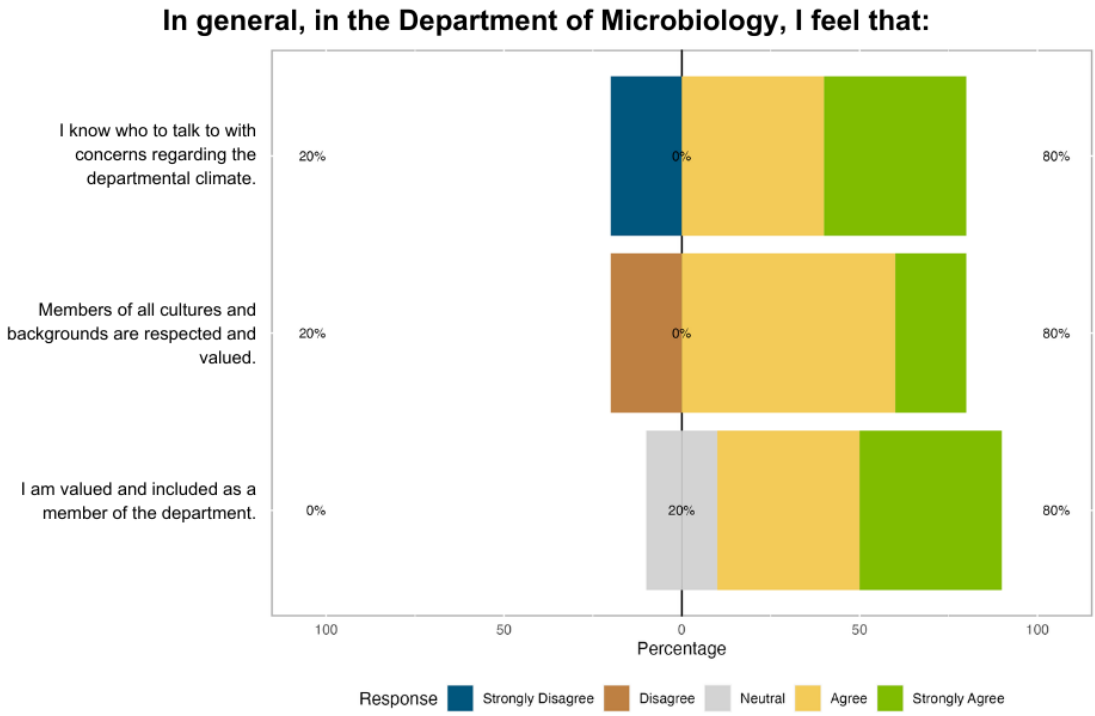

Figure 59. Staff responses regarding departmental climate.

Staff were asked to list the importance of improving the recruitment of fellow department members who are members of URGs (Figure 60). Faculty recruitment was rated the most important, as 80% of staff regard recruitment of faculty with a degree of importance, while 20% feel it is not important. Staff agreed in similar proportions of the importance of student, staff, and postdoctoral recruitment (60% agreeance), while 40% of staff find this not important.

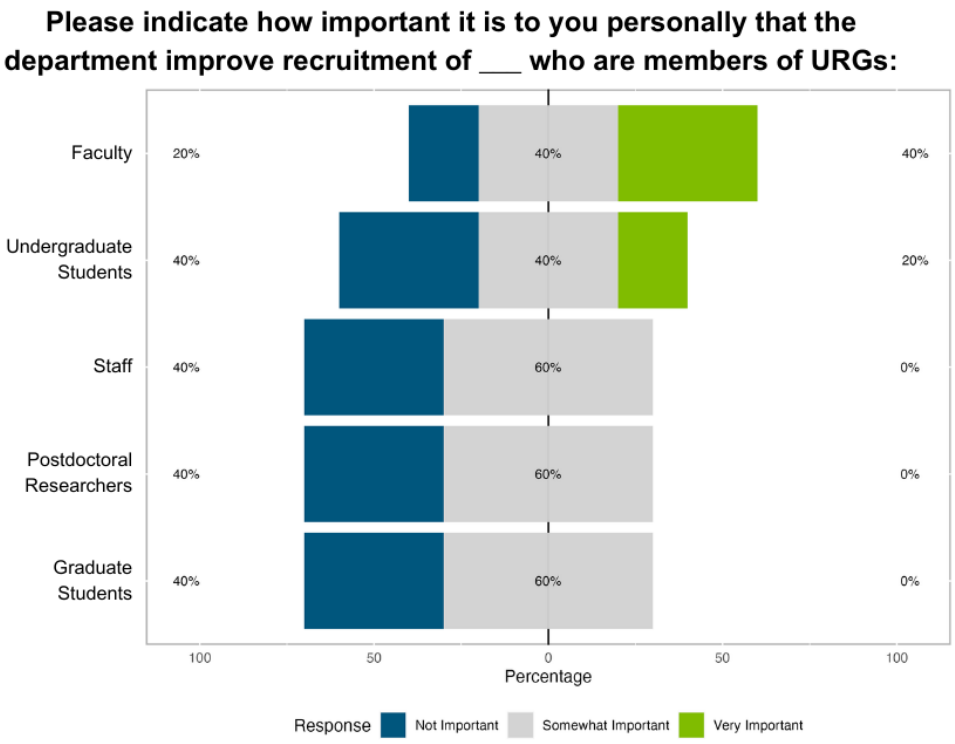

Figure 60. Staff responses regarding URG member recruitment.

Staff were asked questions with regards to departmental action for URG members (Figure 61). Staff feel that educating members about biases and behaviors, as well as URG member representation and compensation holds some degree of importance (80%), while 20% feel as though it is not. Finally, 60% of staff feel a degree of importance for increasing the retention of students from URGs, while 40% do not.

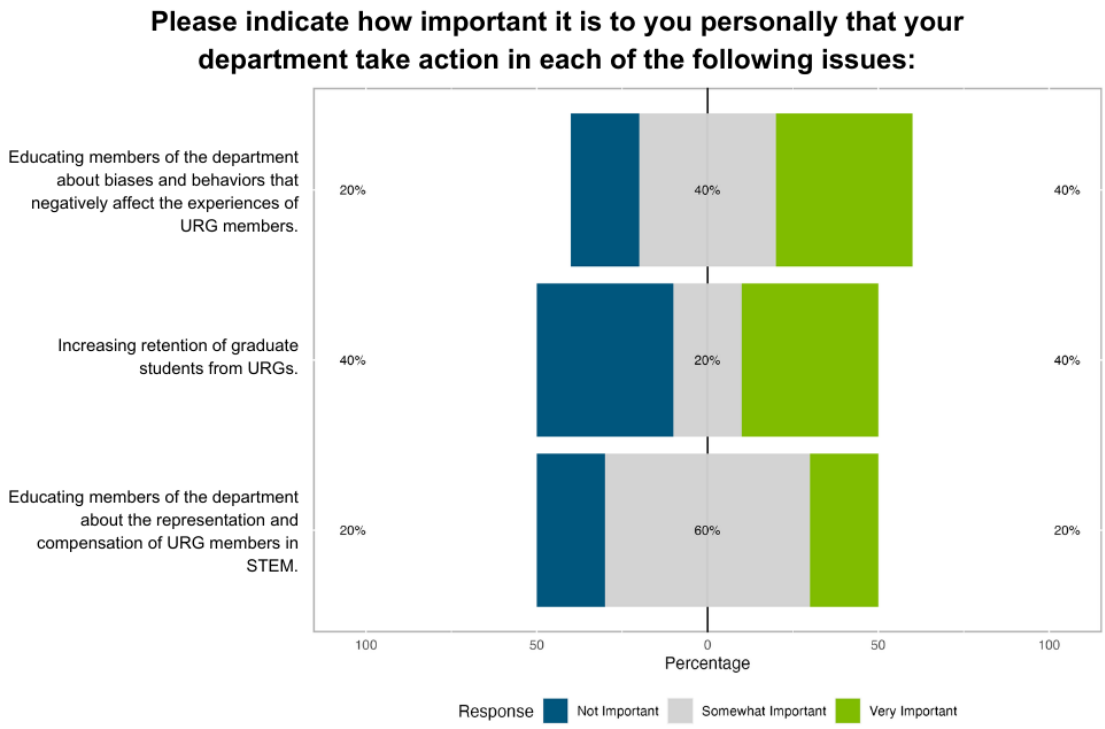

Figure 61. Staff perceptions concerning URG members.

Faculty

Faculty were asked questions aimed to get a sense of their belonging, value, and efficacy (Figure 62). Faculty mostly agree that they are connected to their work (89%) and as though their schedule is flexible (78%). While 67% of faculty agree their leaders are transparent, and as though they are valued, welcome, and included in the department, 22% of faculty disagree. 67% of faculty feel as though they have access to resources for success, while 11% do not. With regards to recognition, 44% of faculty feel they are recognized for their contributions, while 22% of faculty feel as though they are not. Additionally, with regards to their academic college (CAFSNR), 44% of faculty feel valued, welcome, and included, while 22% do not feel valued and 11% do not feel welcome or included.

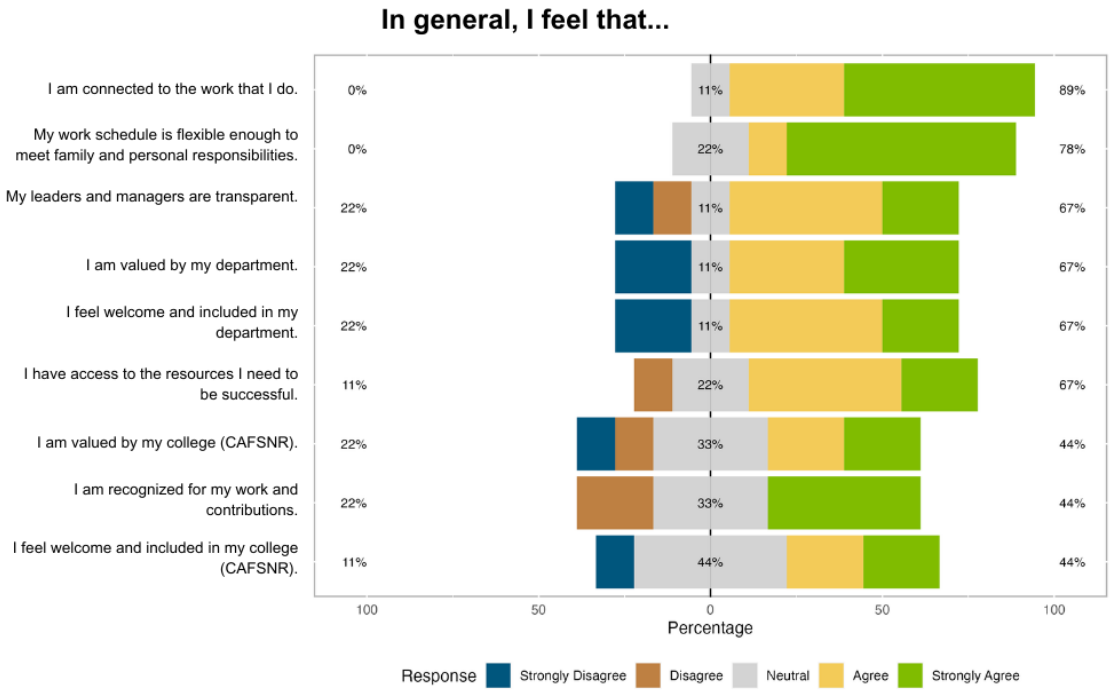

Figure 62. Faculty perceptions of efficacy, belonging, and value.

Faculty were asked questions related to providing student support and environment (Figure 63). Majority of faculty agreed with the statements provided: 89% feel as though they are comfortable directing students to resources on campus, are available for advice concerning their students research, and foster a collaborative environment between group members. However, 11% of faculty disagree with the latter.

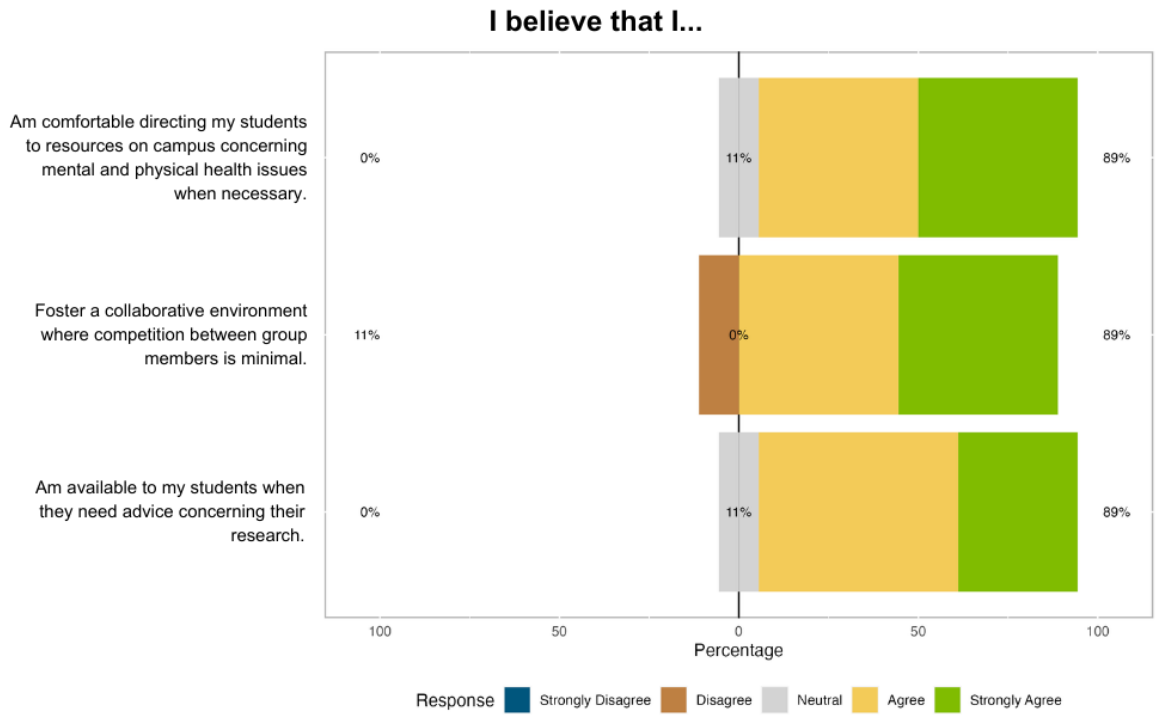

Figure 63. Faculty perceptions of student support.

Faculty were asked specifically about academic publications and their perception of its value (Figure 64). Majority of faculty (78%) feel that publication impact is more important than publication quantity. Additionally, the same percentage of faculty feel that publishing is an important metric of their success, while 22% disagreed. Regarding publication expectations for their students, 22% of faculty agree that publication record is their primary metric for their students' success, while 56% disagree.

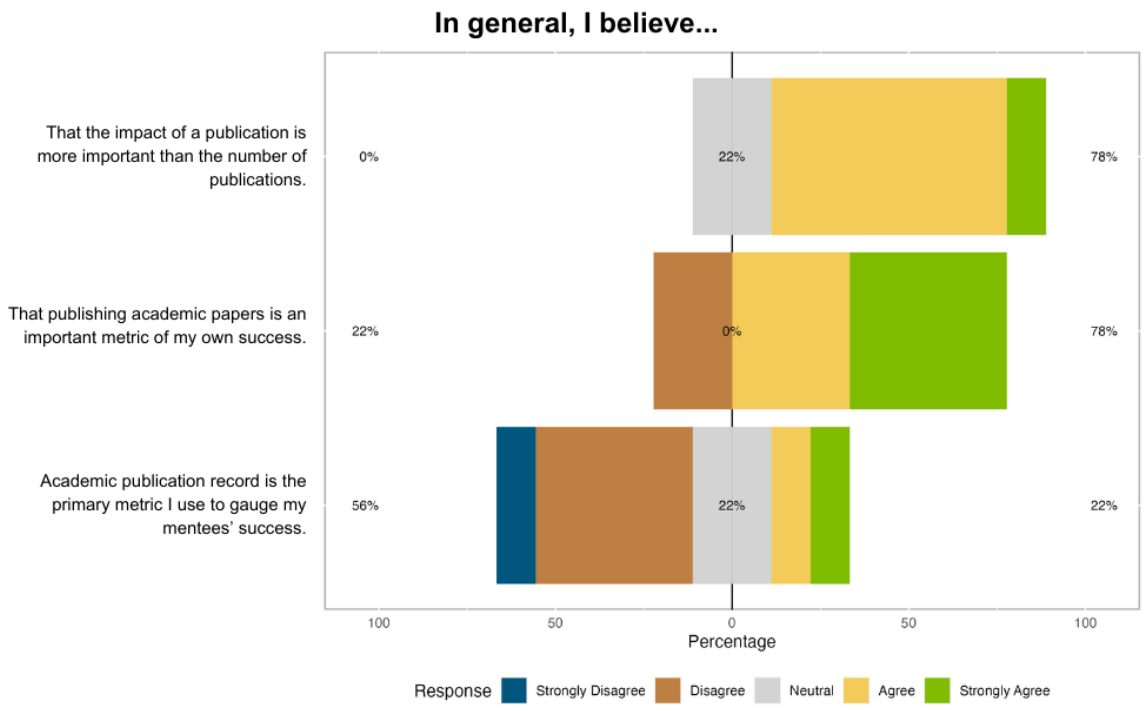

Figure 64. Faculty perceptions of values regarding academic publications.

Following academic publication value for their research students, faculty were asked to identify the metrics they used to gauge their graduate student success (Figure 65). Faculty referenced the scientific method, science communication, problem solving, learning, publishing/presenting research, contributing to the field, preparing for future success, and growth in their experience as metrics for success. Most commonly, faculty referenced helping their students find their purpose or passion as success.

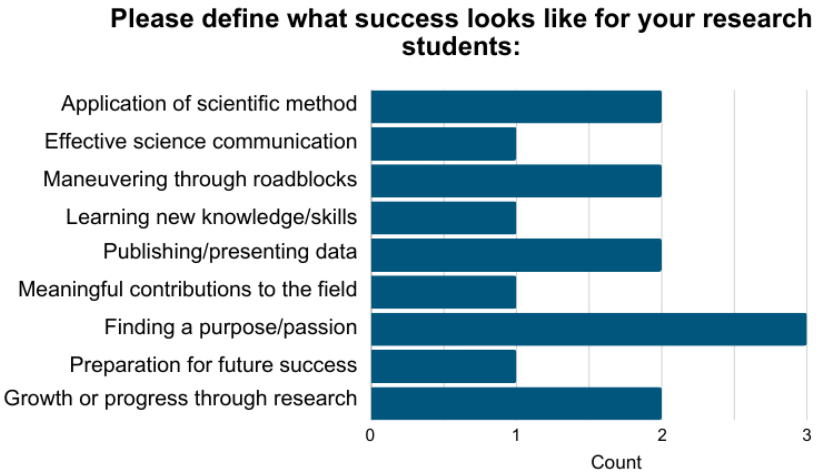

Figure 65. Faculty responses to metrics of success for research students.

Additionally, faculty were asked to define success for their students in their classroom and academic setting (Figure 66). Faculty referenced meeting course outcomes, content understanding, skill acquisition and development. These slightly differed from metrics for their research students, although preparation for future success was mentioned as success for both groups. Finally, most mentioned was skills or attributes specifically related to the student.

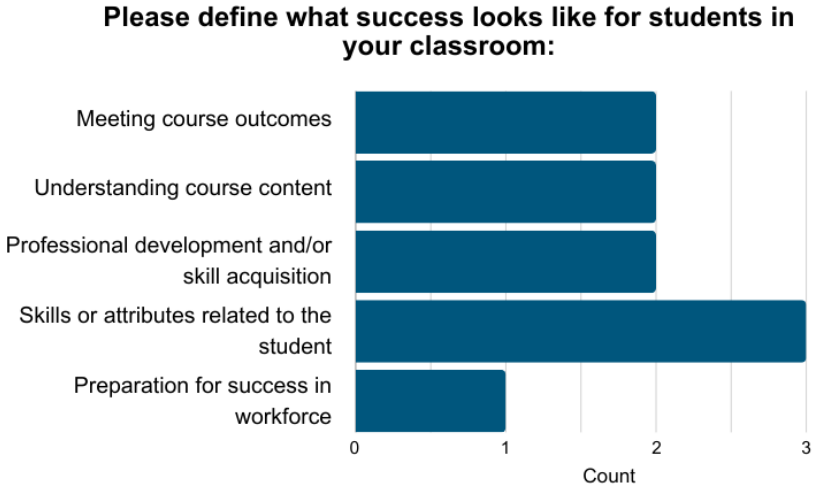

Figure 66. Faculty responses to metrics of success for students in the classroom.

Faculty were also asked to define success for them in their roles (Figure 67). Faculty mentioned meeting deadlines, being productive, and continuing education as a success metric,

although less common. Most referenced was measuring their success by how successful their students were, being good mentors to students, and having positive contributions and/or recognitions for their work.

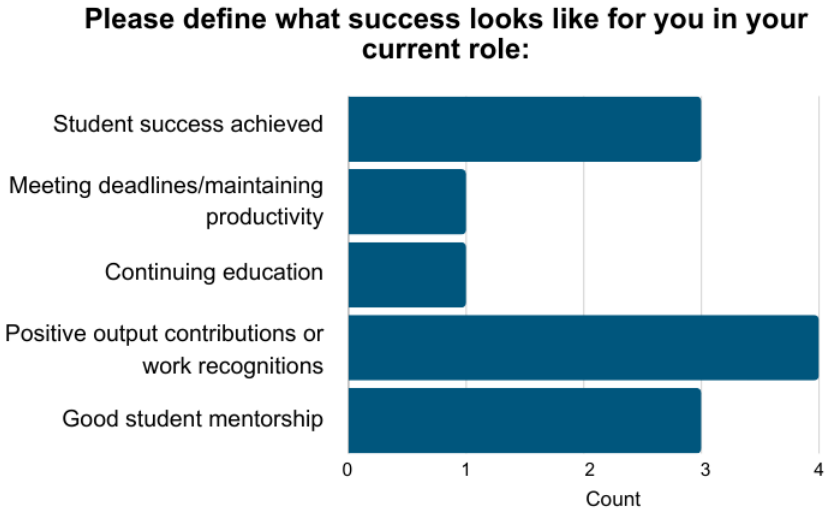

Figure 67. Faculty responses to metrics of success for self.

Faculty were asked questions to get a sense of the relationships with their colleagues (Figure 68). Over half (56%) of faculty feel comfortable seeking advice or feedback from other colleagues, while 22% do not. Additionally, 44% of faculty feel a sense of mutual respect between faculty members, while 22% do not. Finally, an equal percentage of faculty agree and disagree that faculty members cooperate and collaborate (33%).

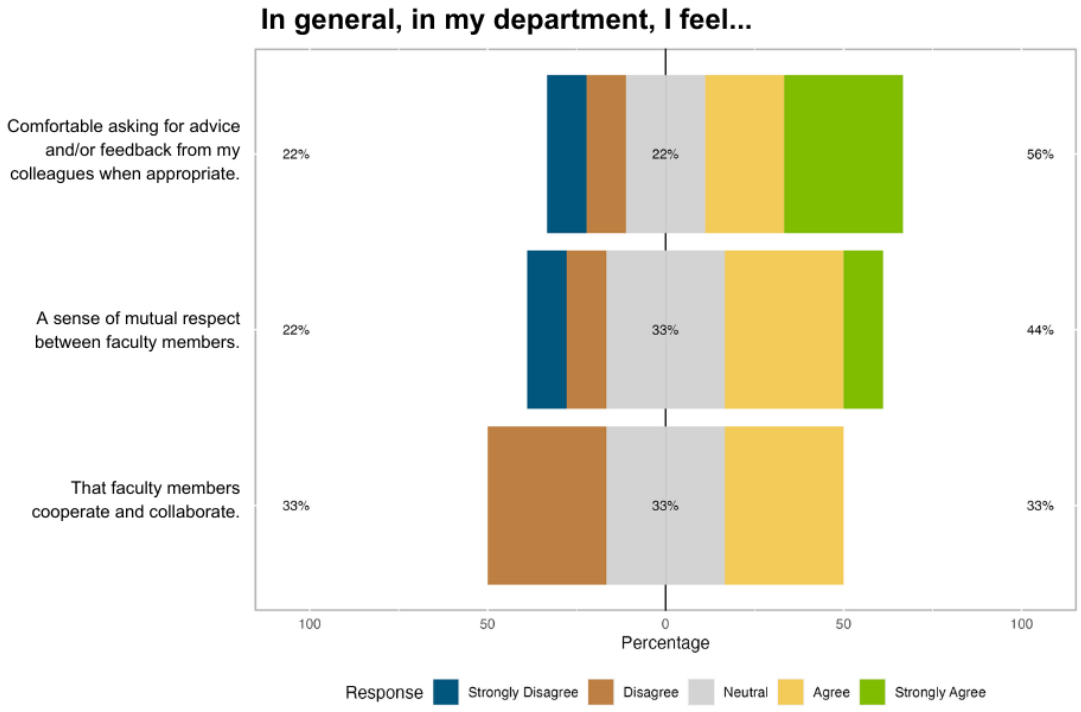

Figure 68. Faculty perceptions regarding department colleagues.

Faculty were asked questions related to behavior and inclusion within the department (Figure 69). Just over half of the faculty (56%) feel that harassment and exclusionary or offensive behavior is not tolerated, while 44% and 33% feel the opposite, respectively. Additionally, while 33% of faculty feel there is sufficient discussion and action regarding equity and inclusion, 44% feel as though there is not.

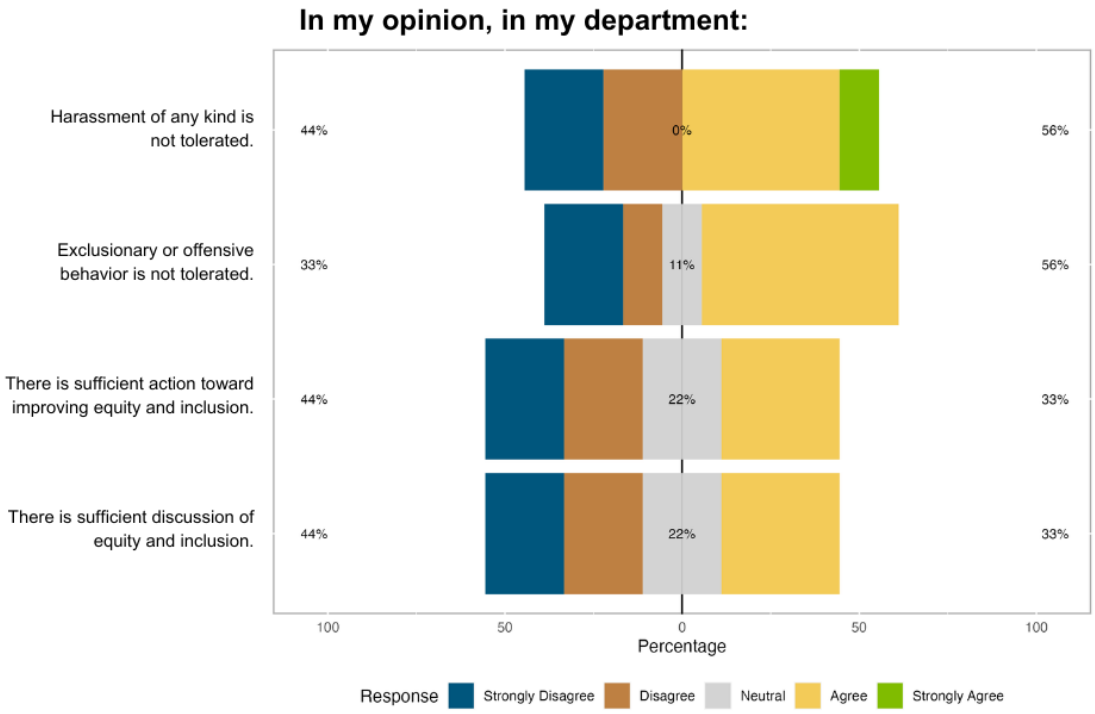

Figure 69. Faculty perceptions regarding behavior and inclusion.

Regarding department climate, faculty responses are displayed in Figure 70. 67% of faculty feel valued and included in the department, while 22% do not. Additionally, while 44% of faculty feel they know who to talk to regarding department climate, 22% feel they do not. Finally, 44% of faculty feel members of all cultures/backgrounds are respected and valued in the department, while 33% feel the opposite.

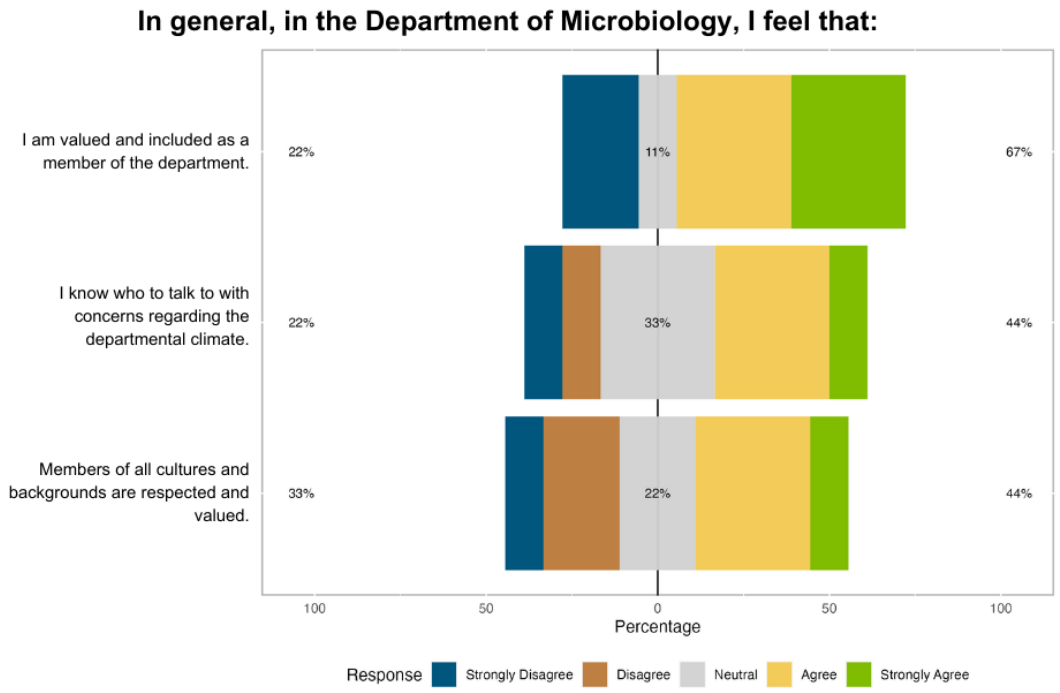

Figure 70. Faculty perceptions of department climate.

Faculty were asked questions regarding the recruitment of members of URGs (Figure 71). All faculty responded they felt some degree of importance regarding recruiting faculty, students, staff, and postdoctoral researchers from URGs. Faculty regarded recruitment of other faculty and graduate students from URGs with a higher degree of importance than the other three cohorts.

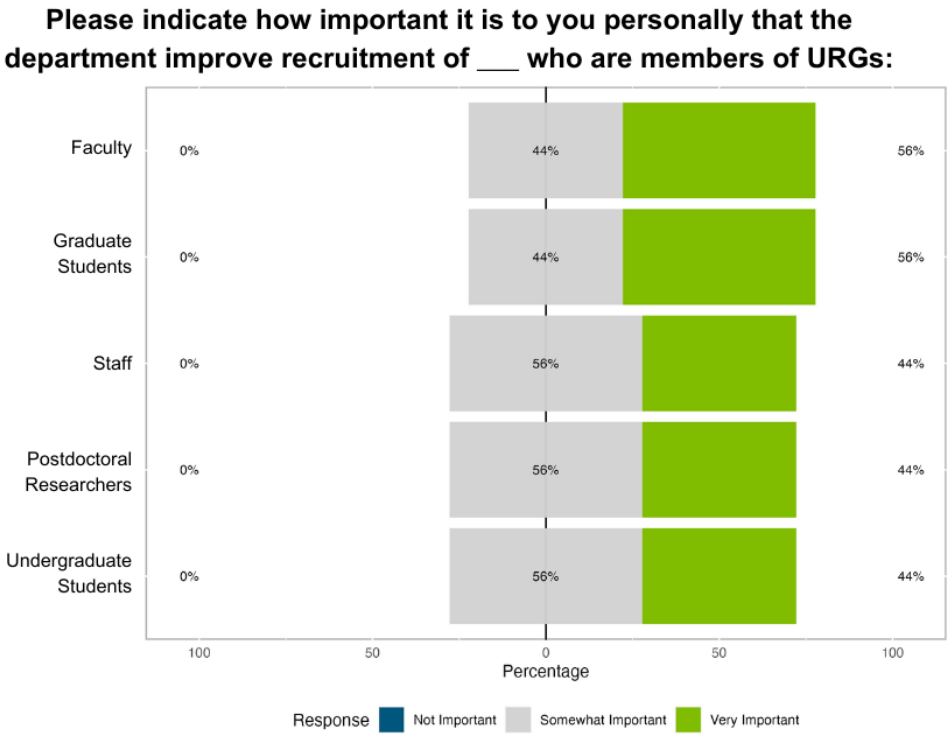

Figure 71. Faculty perceptions of recruitment of URG members.

Additionally, faculty were asked the degree of importance related to URG members and departmental action (Figure 72). All faculty felt a degree of importance in the same proportions for all three statements: educating department members about biases and behaviors that negatively impact URGs, educating department members about URG representation and compensation, and increasing graduate student retention of members or URGs.

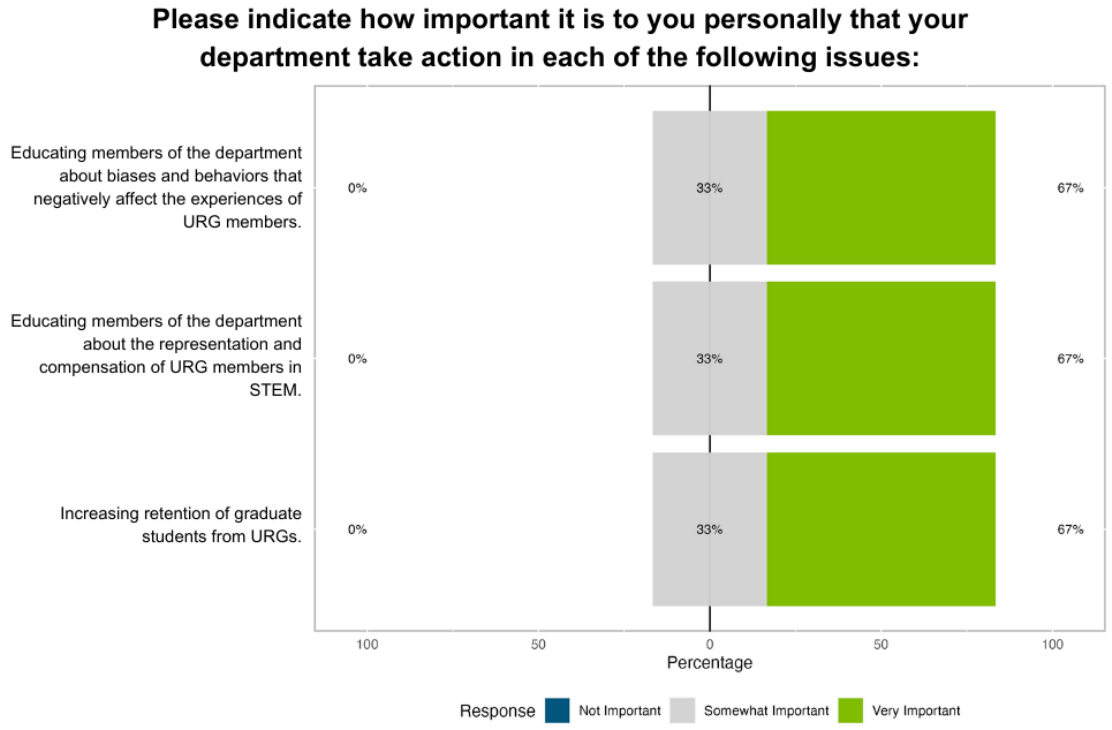

Figure 72. Faculty perceptions with regards to URG members.

Staff and Faculty

Finally, faculty and staff were asked to rank their work-life balance, and both their rankings and rationale are displayed in Figure 73. The average faculty rating was 6.3, and the average staff rating was 8. Themes were observed with regards to their rationale. While both faculty and staff mentioned many commitments and/or time constraints, this was more common in faculty responses. Both staff and faculty included overall good balance and time flexibility in equal proportions. Only faculty mentioned the demanding nature of their work as rationale for their ranking.

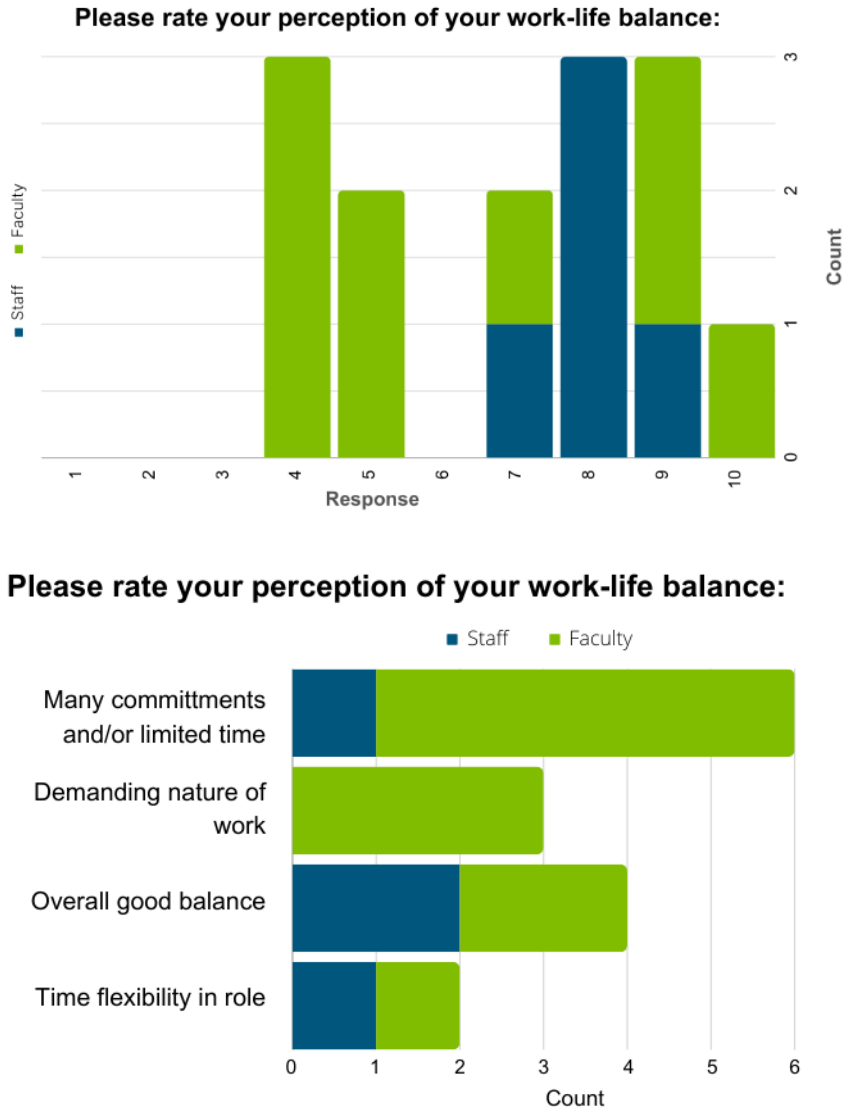

Figure 73. Faculty and staff work-life balance and themes observed in rationale. Scale of 1 (poor) to 10 (excellent).

Discussion

Before interpreting results and drawing comparisons between cohorts, it is important to note what is considered "significant" in terms of responses. While this is up to the discretion of those reading the results, significance can vary based on the frame of reference. For example, while an 80% positive response may be the majority opinion, that leaves 20% of a cohort feeling negatively about any one thing. It is important to determine what proportion of a positive

perception is sufficient for positive department climate. The discussion presented below is solely to compare deficit responses to identify potential areas to improve department climate. For this authors purposes in this discussion, anything greater than 20% is considered significant enough to report and should be considered significant enough to target for solutions.

Undergraduate students

Overall, it appears that undergraduate students feel supported in the department and have positive experience with department members. Undergraduate students reported positive experiences with their research advisors, although just under a third do not feel comfortable disclosing their health conditions that may impact their work with their advisor. Although undergraduates feel their advisor advocates for them and provides non-research advice, when necessary, 20% of undergraduates feel their advisor does not provide emotional support nor do they foster a collaborative work environment. Overall, undergraduates most common response for research success is impactful results, and their most common response for success in their career is acquiring skills or techniques needed. Generally, undergraduates had positive sense of the teaching quality in the department, with primarily positive attributes about their instructors. However, these students felt they had a more inconsistent school-life balance, with course/lab work having mixed results (either being ubiquitous or manageable), but that work supersedes personal time. Finally, undergraduates feel positively about equity and inclusion within the department and have a positive sense of the environment and behavior of others.

Graduate students

Overall, graduate students appear to have a strong sense of belonging within the department. Most students feel comfortable attending social events or seeking advice from other faculty. Graduate students report positive experiences with all members of the department, but

25% of graduate students report negative experiences with their advisor. Many graduate students do not feel comfortable speaking with their advisor about non-academic career paths (44%) or disclosing health conditions that may impact their work (38%). Additionally, while most graduate students feel their advisor provides constructive feedback about their work and are each to talk to about research, a portion of graduate students feel their advisor is not available concerning help with research (21%) nor do they feel their advisor treats their ideas with respect (29%). In terms of research success, the most common success metric mentioned was meeting goals or achieving outcomes. Success for future preparation was highly varied. In regard to teaching, graduate students rated their instructors in general above average, and commented on both positive and negative attributes – with instructor being engaged/not engaged in teaching as the most common for both. Graduate students also reported a highly varied school-life balance, and the most common theme was a sense of work superseding personal time. Finally, while most graduates feel positively about the equity and inclusion in the department, there is a desire for greater discussion of equity and inclusion within the department (25%).

Staff

Staff appear to have an established sense of belonging in the department, as well as efficacy and value. However, a good proportion of staff do not feel belonging within their academic college. Staff generally feel comfortable providing adequate support for students, and comfortability seeking advice from colleagues. With regards to equity and inclusion, staff feel there is sufficient discussion and action regarding equity and inclusion, despite 20% feeling that harassment and exclusionary/offensive behavior is tolerated. The same proportion do not know who to discuss department climate concerns with, and as though members from different backgrounds are not all respected or valued. Interestingly, staff feel that recruiting diverse staff,

graduate students, and postdoctoral researchers is not important, while recruiting diverse faculty is.

Faculty

Faculty had varying responses regarding value and belonging. Just over 20% of faculty do not feel valued or welcome and included in the department, valued in their academic college, recognized for their work and contributions, or that leaders and managers are transparent. In this case, since it was not specified, leaders and managers may apply to the department, college, or university. Additionally, 22% of faculty do not know who to discuss department climate concerns with. Faculty feel a general positive sense of the support they provide for their students. Faculty definitions of success for their research students was highly varied, but finding a purpose or passion was the most frequent theme. While definitions of success for their students in the classroom also varied, the most common theme was skills or attributes related to the student. When defining success for themselves, faculty most mentioned positive contributions or work recognitions, with student success and mentorship being tied for second. When discussing department colleagues, some faculty do not feel a general sense of mutual respect (22%) or a sense of cooperation and collaboration (33%). With regards to behavior and inclusion, nearly half faculty feel there is not sufficient discussion or action with regards to equity and inclusion (44%). Additionally, a large proportion of faculty feel harassment is tolerated in the department (44%), that exclusionary and offensive behavior is tolerated (33%), and that members of all backgrounds are not respected or valued (33%). Finally, faculty overall feel that recruiting diverse students, staff, and faculty is very important, and that education related to URG members is very important.

Staff vs Faculty

As employee retention and experience is vital for student retention (see Chapter 1), it is imperative to identify potential climate issues between employee cohorts for better targeted solutions. Faculty had a larger proportion of respondents feeling as though leaders were not transparent, and were not welcome, included, or valued by the department (22%, Figure 62), than staff (0%, Figure 52). Staff feel less valued by CAFSNR (40%, Figure 52) than faculty do (22%, Figure 62), although they seem to feel not welcome or included in similar proportions (Figure 52 and 62, respectively). About 20% of both staff and faculty do not feel recognized for their contributions (Figure 52 and 62, respectively). Future solutions for this could be increased communication from leadership with a focus of transparency and striving to recognize employees for their contributions. Feelings related to value and inclusion in the department may have deeper roots regarding employee treatment, as alluded to in the following analysis.

Faculty appear to have a more negative perception of department climate than staff. For instance, 33% of faculty feel that members of all cultures/background are not respected or valued (Figure 70), while 20% of staff disagreed with this statement (Figure 59). Additionally, while 20% of staff feel that harassment or exclusionary or offensive behavior is tolerated (Figure 58), 33% of faculty feel exclusionary/offensive behavior is tolerated and 44% of faculty feel harassment is tolerated (Figure 69). Finally, only faculty disagreed that there is sufficient discussion and action towards equity and inclusion (Figure 69). These trends may be informing feelings related to value and inclusion and should be a targeted solution for management and leadership to focus on to improve employee morale. Potential for additional surveying may provide better direction for these targeted solutions, but it appears that more open discussion

regarding department climate, inclusion efforts, and interactions between colleagues can be a good start to closing these gaps.

Undergraduate vs Graduate students

While there are slight variations in responses between graduate students and undergraduate students, there were clear differences in advisor-relationships between undergraduate and graduate students. Graduate students were the only cohort to rate negative experiences with their advisors, as 25% of current graduate students have poor or below average experiences (Figure 41). While undergraduates responded positively to their research advisor's mentorship (Figure 29), graduate students reported some negative feelings regarding their mentorship (Figure 42). A greater proportion of graduate students (44%, Figure 40) do not feel comfortable discussing non-academic career paths with their advisors compared to undergraduates (14%, Figure 27). Additionally, while graduate and undergraduates have similar rates of feeling uncomfortable disclosing their mental and/or physical health conditions with their advisor (Figure 40 and 27, respectively), a greater proportion of graduate students responded more strongly than undergraduates (selecting "strongly disagree" more so than "disagree"). These results allude to the notion that, while advising may be a negative experience for both student cohorts, graduate students may be more dissatisfied with their mentor relationship than undergraduates. Strengthening advising and mentorship can positively benefit both cohorts, but it is important to start addressing these concerns specifically within the graduate student cohort, as these students seem to be facing more discontent.

Mentees vs mentors

The comparison of undergraduate and graduate students alluded to a potential disconnect in advising. Thus, it is important to compare relationships between mentees, either undergraduate

or graduate students, and mentors, either faculty or staff, to identify these gaps. Comparing perceptions regarding these relationships are important for identifying value-congruence, mentorship, and working environment.

Firstly, there appears to be a disconnect in metrics of success for graduate students. Almost 80% of graduate students feel that publication record is an important metric of their own success, despite 64% feeling that it should not be the primary metric (Figure 44). Additionally, 64% of graduate students agree that publication record is their mentor's primary metric of success (Figure 44). However, over half of the department faulty (56%) disagreed that this was their primary metric for their students' success (Figure 64). This discrepancy in reporting highlights that there is conflict in perceived metrics of success for graduate students and their mentors, and there may be a disconnect in communicating and aligning expectations. It would better serve both graduate students and faculty advisors to spark conversations within their labs about specific success metrics to provide better guidance for both the mentee and the mentors.

Secondly, there is a disconnect between undergraduate metrics of success for their research and staff or faculty advisor success metrics. Undergraduate students most referenced impactful results as an important metric for success in their research role. While staff and faculty mentioned this theme in their responses for their research student success, it was among their least common responses. Staff mentioned learning new skills as the most common metric for research student success (Figure 55), and faculty mentioned finding a purpose or passion as the most common success metric (Figure 65). This further strengthens the notion of a disconnect for metrics of success between research students and advisors, as both undergraduate and graduate students exhibited differences between staff and faculty responses. It is important for research

advisors to start conversations to align expectations and discuss success metrics for both graduate student and undergraduate student researchers.

Finally, there appears to be conflict in mentee-mentor support. Over a third of graduate students (36%) feel their advisor does not provide emotional support, non-research advice, or foster a collaborative environment (Figure 43), and 20% of undergraduates feel their advisor does not foster a collaborative environment or provide emotional support (Figure 30). However, 89% of faculty and 60% of staff feel they foster a collaborative environment within the lab (Figure 63 and 53, respectively). Additionally, despite 89% of faculty and 80% of staff feeling they are available to provide advice regarding their mentee's research (Figure 63 and 53, respectively), over 20% of graduate students feel their advisor is not available for help concerning their research, and almost 30% feel their advisor does not treat their ideas with respect (Figure 42). These discrepancies highlight a difference in student perceptions of their mentee-mentor relationship compared to faculty and staff perceptions, as well as differences in perceptions of their working environment. Both providing support and aligning expectations appear to be strong gaps that must be addressed between mentor dyads.

Conclusion

While the survey was primarily designed to gain a better understanding of the department climate from the perception of student and employees, it was also created to compare these perceptions between the cohorts. These cohort comparisons allow for better targeted solutions, as groups may be experiencing different climate issues or a dissonance that leads to climate issues.

There appears to be a misunderstanding of expectations and outcomes from a student and advisor perspective. Gaps in mentee-mentor values and not having clear metrics of success can harm student productivity and retention (28, 43). It is important to discuss expectations and

metrics of success with mentees, and establishing those conversations within each lab in the department may be of benefit to student researchers. Additionally, discussing expectations is important for all members of the research group, including students, staff, postdoctoral researchers, and faculty, so success metrics are uniform for all interactions within the lab. In addition, there is a clear discrepancy between how faculty perceive their mentorship and laboratory environment and how the students perceive it. Professional development and mentorship training for advisors can serve as a positive tool for navigating these situations and fostering stronger mentee-mentor relationships (90, 91). Prioritizing mentorship skills and relationships is important for student success and experience (40, 72, 92), which in turn influences student retention. Supporting development of mentors through training such as CIMER Entering Mentoring allow better skill acquisition to navigating these challenges and mitigating barriers. Future implementations should include mentorship development for research faculty and advisors to help better support students, specifically graduate students, and help alleviate some of the negative feelings regarding advising and support.

Additionally, there are clear discrepancies in the climate of the department, specifically focusing on equity, inclusion, and recognition of employees. It is important for leadership and management to mitigate these negative impacts to improve employee experience. Work environment is important for employee satisfaction, job performance, and retention, which also provides benefits to students within that program (Chapter 1). While declining enrollment and retention of students can negatively impact the academic department, it is also important to focus on a positive work environment and prioritize employee retention. Previous published literature utilizing climate survey data to inform continuous efforts, including discussion of mental health, incorporating student feedback in hiring decisions, and incorporating diversity and inclusion

discussions, have shown to improve the perception of academic climates (78). Doing so for the Department of Microbiological Sciences can mitigate these negative feelings, improve department environment for both students and employees, and improve climate perceptions.

This study serves as a starting point for identifying areas of targeted improvement for both student and employee experience and well-being within the department. Narrowing these gaps and strengthening initiatives can have a positive impact on both student and employee retention. It is also important to focus both on employee and student development and satisfaction to have the most positive influence on retention outcomes. While this is specific to the Department of Microbiological sciences, this study also serves as an example for other academic departments to identify and target climate issues to prevent student and employee attrition and improve their environment for future generations of students.

CHAPTER 4: DISCUSSION

Retention in higher education has been heavily researched for decades and is a common focus for higher education institutions. While theoretical models exist and are commonly applied to retention research, their stepwise and longitudinal nature limit their application. Influences of retention are highly varied, and decisions to leave an institution are individualized for the unique student. Utilizing a more fluid and holistic way of thinking, specifically systems thinking, allows for better conceptualization of these retention influences and their interconnections. The theorized systems map presented in Chapter 1 (Figure 9) allows for a broader application of retention-focused interventions for each unique student who may be at risk. This allows universities to better support retention initiatives and ensure that students are retained within their system.

Instituting a retention-focus is important not only to retain students within a university, but also encourage their persistence within their disciplines into the workforce. This is especially important for students pursuing degrees and careers in STEM fields. Despite the increasing workforce need for careers in STEM fields, the vast majority of students pursuing a STEM degree are choosing non-STEM careers (5). Creating an opportunity to promote STEM persistence and workforce development for students in their degree paths may be beneficial for fulfilling these workforce needs. The ND-ACES project serves as just that. Establishing a virtual community model to provide mentorship, professional development, and support in research allowed these students to build a greater sense of belonging in STEM, develop their skillsets, and contribute to their STEM persistence intentions. Past participant data for the RTG program showed that a majority of previous students had persisted into the STEM workforce. While dREU students were majority still enrolled as students, those who had moved on to the

workforce were mostly in STEM careers. Despite the limited sample size of participation, and additional influences outside of the ND-ACES program that may influence the student's retention and persistence in STEM, it provides examples of potential student-centric interventions that can contribute to retention on a greater scale.

While student-centric interventions can be of benefit, it is important to recognize that an institutional view of retention is also important. Institutions often provide resources and services that are student-facing and influence student experience, and retention initiatives tend to focus on that. However, institutions employ individuals that foster many of those relationships, and it is important to acknowledge employee influence on student retention. Employees of an institution can have vast influences on students, including their decisions to remain at their university (Figure 9). Promoting retention of employees is also vital to ensuring student success and retention. Oftentimes, for both students and employees, their environmental climate plays a key role in their satisfaction, performance, and retention overall (93, 94). The Department of Microbiological Sciences study serves as an avenue to explore this area further. Students and employees were surveyed regarding their perception of the department climate, and the results hint at potential underlying issues that may be influencing their experience. Faculty tended to respond more negatively than staff, both in terms of the college as a whole and within their department, and interpersonal relationships seemed to be at the heart of this discourse. Graduate students tended to respond more negatively than undergraduates, and most negative comments related to their view and relationship with their advisors. There also appeared to be a strong disconnect in an advisee's view of their relationship than their advisor, including the level of support provided by the mentor to the mentee. This provides insight into many potential climate issues, but also specific areas that appear to be harming the experience for students and

employees, highlighting potential avenues for solutions. This data contributes to how important institutional action is in terms of contributing to retention of students and employees, and how addressing these on a wider scale will provide a more overarching befit.

While seemingly two discrete studies, Chapter 2 and Chapter 3 provide similarities that may hint at a larger issue in higher education as a whole. For instance, the dREU program participants mentioned ineffective mentorship, including frustration with supervisor and lack of guidance/communication that impacted their view of the program (Tables 7-9). This theme of dissonance in research advisor relationships was also observed in the climate study for the Department of Microbiological Sciences, where both graduate and undergraduate students feel unsupported by their mentor (Figures 30, 42, and 43). This alludes to a trend that can be detrimental to student success and retention, being that an advisor's mentorship can shape their research experience (95). Mentorship can influence student retention within an institution and influence student persistence through academia and into the STEM workforce (81, 92). There is a disconnect between mentorship support provided and received, and closing this is vital for mitigating any negative influences on student retention. The research provided in both studies indicate the importance and overall impact of mentoring in the larger picture of retention and STEM persistence.

Acknowledging the influence of these gaps in advising and mentorship support on the overall system of retention is necessary to establish buy-in for solutions. Mentorship often comes in different forms. Depending on the cohort of the student, mentors can serve more as academic advisors (particularly for undergraduate students) or research advisor (particularly for graduate students). While not all advisors are mentors, and not all mentors are advisors, those roles tend to overlap. For the purpose of the systems map, mentors and advisors are lumped into the same

element. Figure 74 depicts a downstream effect if insufficient advising occurs for students. Poor advising results in insufficient institutional support for the student and can oftentimes result in poorer instructor support for the student. This contributes to academic performance, goal commitment, engagement, academic commitment, and sense of belonging for the student. Additionally, a disconnect between students and mentors or advisors is impacted by a disconnect between values, which negatively feeds into academic commitment and performance. The interconnection of these variables shows the important of providing adequate and sufficient advising for student needs and highlights the importance of mitigating the gaps observed in both study populations. Solutions such as professional development for advisors, mentorship training, and sparking discussion between advisors and advisees can be of benefit to closing these gaps and restoring the balance of the retention system.

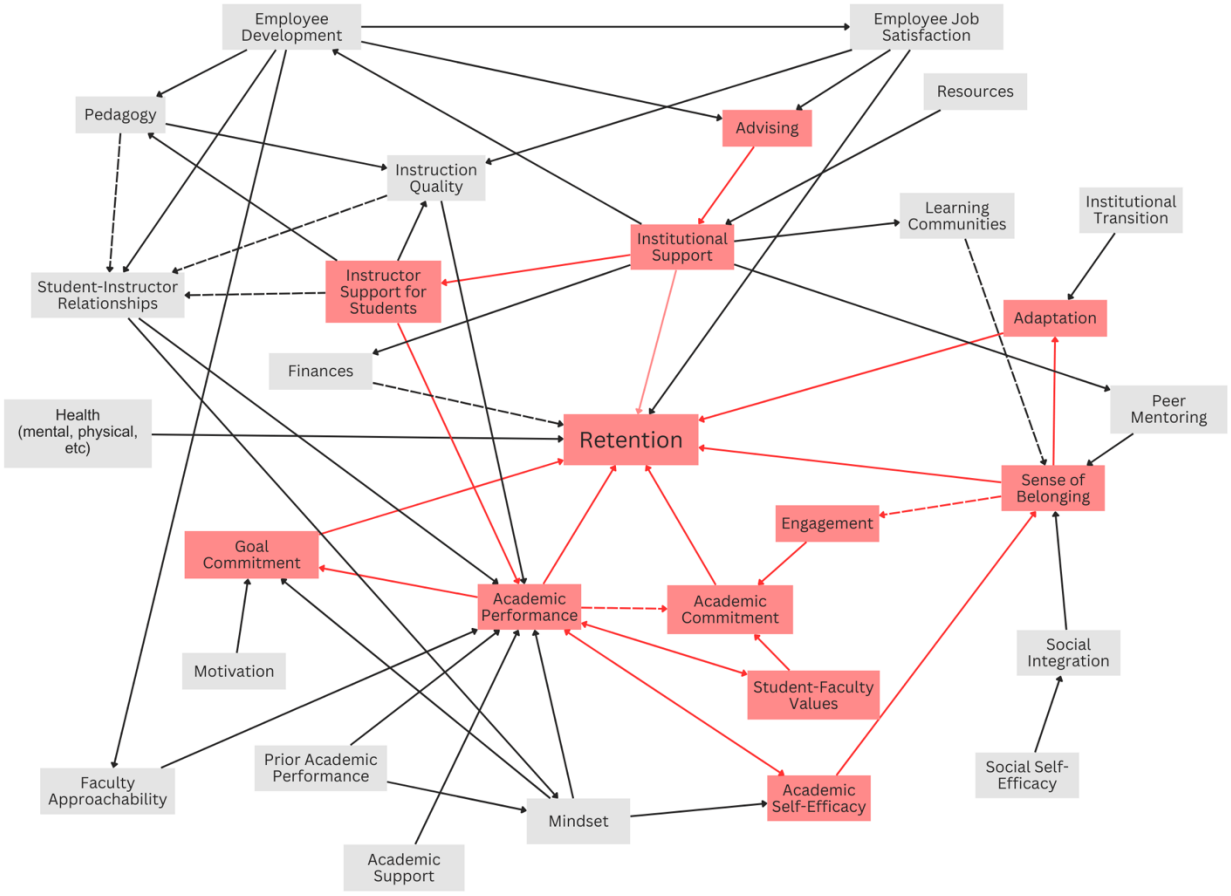

Figure 74. Poor advising influence on student persistence.

Figure 74, along with those presented in Chapter 1, provide a more efficient manner of understanding the convoluted nature of persistence and retention of students in higher education. Persistence and retention are linked and influence each other, and a failure to obtain either can result in attrition (Figure 1). What is most important, however, is to acknowledge the use of a systems map in characterizing retention influences (Figure 9). This map serves as a tool to gaining a better understanding of elements that influence student retention, and how these elements influence each other. As perturbations in various scenarios have presented (Figure 7, 9 and 74), a singular disbalance can significantly disrupt the full system. These disruptions provide opportunities for retention-focused solutions to prevent the lack of harmony among the elements.

There is an important concept to identify that is visible in this systems thinking map: high impact practices. While all elements are interconnected in some manner, there are a few elements that are more connected than others – and can have a more influential impact on student retention. In support from the literature and connections drawn between research, employee development, student-instructor relationships, institutional support, sense of belonging, and academic performance are among the higher impact practices. These elements are shown highlighted in Figure 75. Due to these elements being exceedingly interconnected, institutions focusing on these elements in targeted solutions may have a more positive influence on student retention overall.

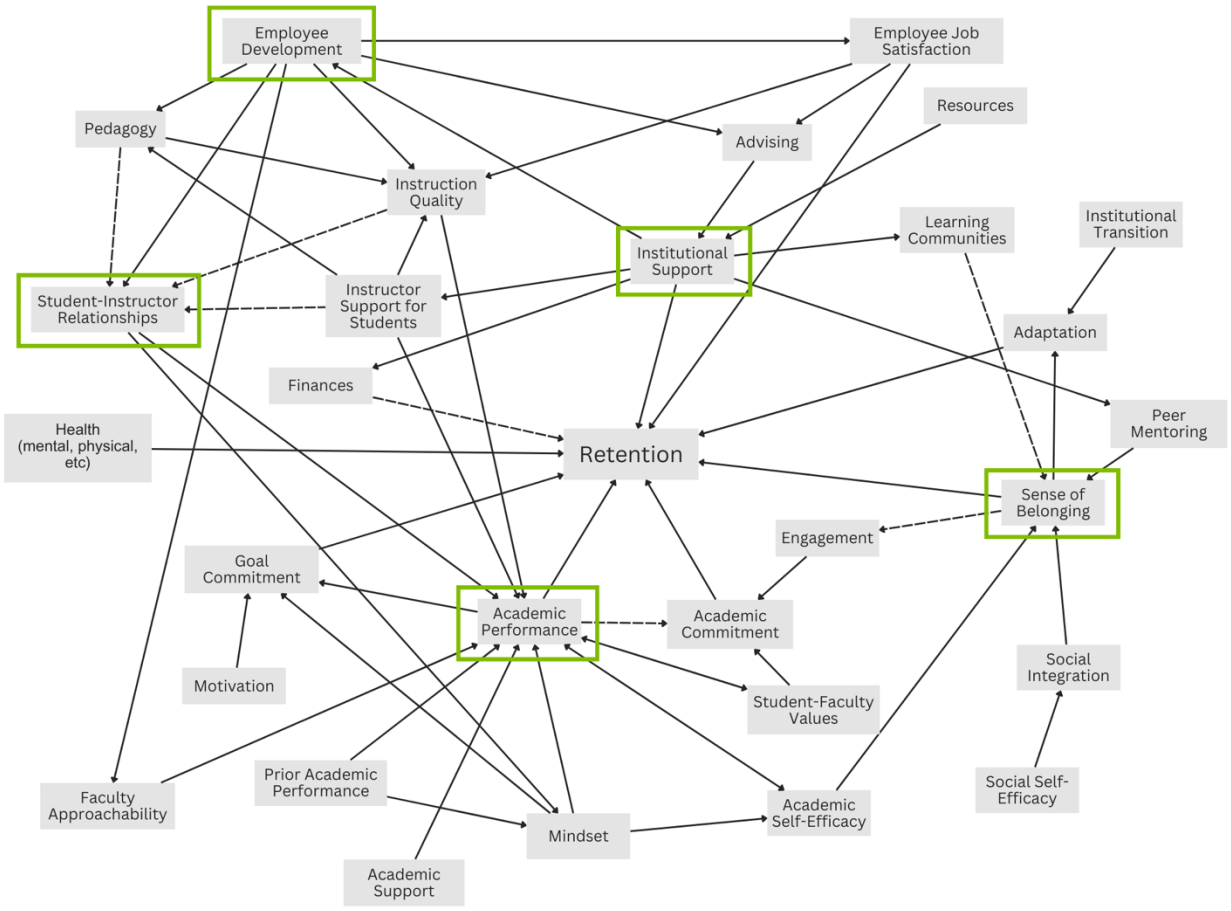

Figure 75. High impact practices for student retention.

This systems map provides a holistic approach to targeting retention strategies for students in higher education. Future research could include statistical analysis for an institution's population to identify which elements are most closely linked and influential to the student. While these high impact practices in Figure 75 detail what is present in the literature, this may vary by institution, academic college, or even at the program level. It would be of benefit for institutions to implement this systems map into their analysis at all levels to gain a better understanding of high impact practices for their specific student cohorts. Additional research could include utilizing data to project retention outcomes based on the changing of each element.

While additional research can be done, this map serves as groundwork for institutions to spearhead different projects and implementing practices. Institutions can use this map to identify what areas may need to be improved related to employee job satisfaction, engagement, and development, and how that would benefit the employees and the students enrolled. Additional policies and practices should be adjusted with these concepts in mind, aligning procedure with desired outcomes to be more student-focused.

In a final note for retention-focused solutions, it is crucial to recognize the two different approaches in which a systems map can be used: an institutional-centered view, and a student-centered view. Both approaches are important and must be implemented, but there is a balance to strike. Too much focus on a student-centric approach leaves elements such as employee development and institutional support unfulfilled, which can significantly impact the student experience and retention via harmed employee experience (see Figure 7). However, too much focus on an institutional-centric solution leaves elements such as establishing a sense of belonging vulnerable, providing a risk to student community building and retention overall.

Thus, while the systems map serves as a more holistic tool for retention influences, interventions should be holistic too, and incorporate both an institution and student centric approach.

Whether utilizing a climate survey to identify unknown areas of improvement, or using existing data to inform solutions, a systems map serves as an effective tool to identify retention elements and their connections with each other. The ability to identify the direct influences students may be facing in their decision to remain at the university, and the downstream effect of ineffective employee support, allows institutions and departments to better serve their populations. Targeted areas for improvement and using a balanced approach to implementing these improvements is vital to maintain employee satisfaction, improve the retention of all students within higher education, and improve persistence in STEM to fill our workforce needs in the coming years.

REFERENCES

1. Grieco E, Deitz S. 2023. Diversity and STEM: The STEM Workforce.

2. U.S. Bureau of Labor Statistics. 2023. Employment in STEM occupations. https://www.bls.gov/emp/tables/stem-employment.htm#ep_table_111.f.1.

3. Noonan R. 2017. STEM Jobs: 2017 Update.

4. Fayer S, Lacey A, Watson A. 2017. STEM Occupations: Past, Present, And Future.

5. United States Census Bureau. 2021. From College to Jobs: Pathways in Science, Technology, Engineering, and Math (STEM). https://www.census.gov/topics/employment/industry-occupation/guidance/code-lists.html.

6. President's Council of Advisors on Science and Technology. 2012. Engage to Excel: Producing One Million Additional College Graduates Within Degrees in Science, Technology, Engineering, and Mathematics.

7. National Science Board. 2022. Science & Engineering Indicators: Higher Education in Science and Engineering.

8. Cannady MA, Greenwald E, Harris KN. 2014. Problematizing the STEM Pipeline Metaphor: Is the STEM Pipeline Metaphor Serving Our Students and the STEM Workforce? Sci Educ 98:443–460.

9. Skrentny JD, Lewis K. 2022. Beyond the "STEM Pipeline": Expertise, Careers, and Lifelong Learning. Minerva 60.

10. National Student Clearinghouse Research Center. 2022. Persistence and Retention: Fall 2020 Beginning Postsecondary Student Cohort.

11. Burke A. 2019. Student Retention Models in Higher Education: A Literature Review. College and University 94:12–21.

12. Durkheim E. 1952. Suicide. Routledge & Kegan Paul Ltd.

13. Spady WG. 1970. Dropouts from Higher Education: An Interdisciplinary Review and Synthesis. Interchange 1:64–85.

14. Tinto V. 1975. Dropout from Higher Education: A Theoretical Synthesis of Recent ResearchSource: Review of Educational Research. Winter.

15. Tinto V. 1997. Classrooms as Communities: Exploring the Educational Character of Student PersistenceSource: The Journal of Higher Education.

16. Bean JP. 1980. Dropouts and turnover: The synthesis and test of a causal model of student attrition. Res High Educ 12:155–187.

17. Price JL. 1977. The Study of Turnover. https://about.jstor.org/terms.

18. Kim DH. 1999. An introduction to systems thinking. Pegasus Communications, Inc.

19. Verhoeff RP, Knippels MCPJ, Gilissen MGR, Boersma KT. 2018. The Theoretical Nature of Systems Thinking. Perspectives on Systems Thinking in Biology Education. Front Educ (Lausanne) 3:1–11.

20. Meadows DH. 2009. Thinking in SystemsEarthscan. Earthscan.

21. Arnold RD, Wade JP. 2015. A definition of systems thinking: A systems approach, p. 669–678. *In* Procedia Computer Science. Elsevier.

22. Davis GM, Hanzsek-Brill MB, Petzold MC, Robinson DH. 2019. Students' Sense of Belonging: The Development of a Predictive Retention Model. Journal of the Scholarship of Teaching and Learning 19:117–127.

23. Bean J, Bogdan Eaton S. 2002. The Psychology Underlying Successful Retention Practices. JCollege Student Retention 3:73–89.

24. Bong M, Skaalvik EM. 2016. Academic Self-Concept and Self-Efficacy: How Different Are They Really? 15:1–40.

25. Dewitz SJ, Woolsey ML, Walsh WB. 2009. College student retention: An exploration of the relationship between self-efficacy beliefs and purpose in life among college students. J Coll Stud Dev 50:19–34.

26. Charalambous M. 2020. Variation in transition to university of life science students: exploring the role of academic and social self-efficacy. J Furth High Educ 44:1419–1432.

27. Alyahyan E, Düştegör D. 2020. Predicting academic success in higher education: literature review and best practices. International Journal of Educational Technology in Higher Education 17.

28. Henry MA, Shorter S, Charkoudian L, Heemstra JM, Corwin LA. 2019. FAIL is not a four-letter word: A theoretical framework for exploring undergraduate students' approaches to academic challenge and responses to failure in STEM learning environments. CBE Life Sci Educ 18.

29. Crosling G. 2017. Student Retention in Higher Education, A Shared Issue. Encyclopedia of International Higher Education Systems and Institutions https://doi.org/10.1007/978-94-017-9553-1.

30. Crosling G, Thomas L, Heagney M. 2009. Improving student retention in higher education: The role of teaching and learning. Australian Universities' Review 51:9–18.

31. Dewsbury BM, Swanson HJ, Moseman-Valtierra S, Caulkins J. 2022. Inclusive and active pedagogies reduce academic outcome gaps and improve long-term performance. PLoS One 17.

32. Sithole A, Chiyaka ET, McCarthy P, Mupinga DM, Bucklein BK, Kibirige J. 2017. Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges. Higher Education Studies 7:46.

33. Kirby LAJ, Thomas CL. 2022. High-impact teaching practices foster a greater sense of belonging in the college classroom. J Furth High Educ 46:368–381.

34. Arif S, Massey MDB, Klinard N, Charbonneau J, Jabre L, Martins AB, Gaitor D, Kirton R, Albury C, Nanglu K. 2021. Ten simple rules for supporting historically underrepresented students in science. PLoS Comput Biol 17.

35. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP. 2014. Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci U S A 111:8410–8415.

36. Franklin S, Hane E, Kustusch M, Ptak C, Sayre E. 2018. Improving Retention Through Metacognition: A Program for Deaf/ Hard-of-Hearing and First-Generation STEM College Students. J Coll Sci Teach 048:21–27.

37. Weuffen S, Fotinatos N, Andrews T. 2021. Evaluating sociocultural influences affecting participation and understanding of academic support services and programs (SSPs): Impacts on notions of attrition, retention, and success in higher education. J Coll Stud Ret 23:118–138.

38. Damkaci F, Braun TF, Gublo K. 2017. Peer Mentor Program for the General Chemistry Laboratory Designed To Improve Undergraduate STEM Retention. J Chem Educ 94:1873–1880.

39. Harichandran RS, Erdil NO, Gillespie S. 2022. College-Wide First Year and Career Mentorship Programs. American Society for Engineering Education 1–13.

40. Harmon J, Lauguico S. 2021. Mentorship, Engagement, and Fall to Spring Retention: How Peer Mentorship Keeps College Students in School.

41. Ikuma LH, Steele A, Dann S, Adio O, Waggenspack WN. 2019. Large-scale student programs increase persistence in STEM fields in a public university setting. Journal of Engineering Education 108:57–81.

42. Grillo M, Leist C. 2013. Academic support as a predictor of retention to graduation: New insights on the role of tutoring, learning assistance, and supplemental instruction. J Coll Stud Ret 15:387–408.

43. Brauer DD, Mizuno H, Stachl CN, Gleason JM, Bumann S, Yates B, Francis MB, Baranger AM. 2022. Mismatch in Perceptions of Success: Investigating Academic Values among Faculty and Doctoral Students. J Chem Educ 99:338–345.

44. Strayhorn TL. 2010. Money Matters: The Influence of Financial Factors on Graduate Student Persistence. Journal of Student Financial Aid 40.

45. St. John EP, Kirshstein RJ, Noell J. 1991. The Effects of Student Financial Aid on Persistence: A Sequential Analysis. Rev High Ed 14:383–406.

46. Britt SL, Ammerman DA, Barrett SF, Jones S, Britt SL;, Ammerman D, Allen ;, Barrett SF; Student Loans, Financial Stress, and College Student Retention Recommended CitationJournal of Student Financial Aid.

47. Burke AO. 2022. The Impact of Professional Staff on Student Success Within Higher Education. Disquisition.

48. Forsman J, Linder C, Moll R, Fraser D, Andersson S. 2014. A new approach to modelling student retention through an application of complexity thinking. Studies in Higher Education 39:68–86.

49. Pascarella ET, Terenzini PT. 2005. How College Affects Students: A Third Decade of Research.

50. Kuh GD, Kinzie J, Buckley JA, Bridges BK, Hayek JC. 2006. What Matters to Student Success: A Review of the Literature.

51. Schertzer CB, Schertzer SMB. 2004. Student satisfaction and retention: A conceptual model. Journal of Marketing for Higher Education 14:79–91.

52. Hong B, Shull P, Haefner L. 2011. Impact of perceptions of faculty on student outcomes of self-efficacy, locus of control, persistence, and commitment. J Coll Stud Ret https://doi.org/10.2190/CS.13.3.b.

53. Chong CY, Lee ST. 2017. Employee Retention and Job Performance Attributes in Private Institutions of Higher Education. International Journal of Business and Administrative Studies 3:158–165.

54. Kossivi B, Xu M, Kalgora B. 2016. Study on Determining Factors of Employee Retention. Open J Soc Sci 04:261–268.

55. Bukhatir A, Al-Hawari MA, Aderibigbe S, Omar M, Alotaibi E. 2023. Improving student retention in higher education institutions – Exploring the factors influencing employees extra-role behavior. Journal of Open Innovation: Technology, Market, and Complexity 9.

56. Miller L. 2019. The Level of Decision-Making, Perceived Influence, and Perceived Satisfaction of Faculty and Their Impact on Student Retention in Community Colleges. Community Coll J Res Pract 43:515–529.

57. Snyman AM. 2022. Predictors of staff retention satisfaction: The role of the psychological contract and job satisfaction among police cadets. Journal of Psychology in Africa 32:459–465.

58. Cabrera D, Cabrera L. 2020. Complexity and Systems Thinking Models in Education: Applications for Leaders.

59. Caison AL. 2005. Determinants of Systemic Retention: Implications for Improving Retention Practice in Higher Education. J Coll Stud Ret 6:425–441.

60. Forsman J, van den Bogaard M, Linder C, Fraser D. 2015. Considering student retention as a complex system: a possible way forward for enhancing student retention. European Journal of Engineering Education 40:235–255.

61. Fry R, Kennedy B, Funk C. 2021. STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity.

62. Anderson MK, Anderson RJ, Tenenbaum LS, Kuehn ED, Brown HKM, Ramadorai SB, Yourick DL. 2019. The Benefits of a Near-Peer Mentoring Experience on STEM Persistence in Education and Careers: A 2004-2015 Study. The Journal of STEM Outreach 1.

63. Zaniewski AM, Reinholz D. 2016. Increasing STEM success: a near-peer mentoring program in the physical sciences. Int J STEM Educ 3.

64. Moreira RG, Butler-Purry K, Carter-Sowell A, Walton S, Juranek I V., Challoo L, Regisford G, Coffin R, Spaulding A. 2019. Innovative Professional Development and Community Building Activity Program Improves STEM URM Graduate Student Experiences. Int J STEM Educ 6.

65. Robertson K. 2012. A Journal Club Workshop for Undergraduates: A Systematic Method for Reading, Interpreting, and Presenting Primary Literature. J Coll Sci Teach 41:25–31.

66. Sandefur CI, Gordy C. 2016. Undergraduate journal club as an intervention to improve student development in applying the scientific process. J Coll Sci Teach 45:52–58.

67. Hsieh HF, Shannon SE. 2005. Three approaches to qualitative content analysis. Qual Health Res 15:1277–1288.

68. Dunlosky J, Rawson KA. 2012. Overconfidence produces underachievement: Inaccurate self evaluations undermine students' learning and retention. Learn Instr 22:271–280.

69. Ehrlinger J, Mitchum AL, Dweck CS. 2016. Understanding overconfidence: Theories of intelligence, preferential attention, and distorted self-assessment. J Exp Soc Psychol 63:94–100.

70. Blanton H, Pelham BW, DeHart T, Carvallo M. 2001. Overconfidence as dissonance reduction. J Exp Soc Psychol 37:373–385.

71. Bi YL, Du XL, Li S. 2013. Peer-comparison overconfidence: Does it measure bias in self-evaluation? Psych J 2:17–25.

72. DeCastro R, Sambuco D, Ubel PA, Stewart A, Jagsi R. 2013. Mentor Networks in Academic Medicine. Academic Medicine 88:488–496.

73. Mph X, Van Sluijs E, Ogilvie D, Patterson R, Panter J, Xiao C, Van Sluijs E, Ogilvie D, Patterson R, Panter J. 2022. Shifting towards healthier transport: carrots or sticks? Systematic review and meta-analysis of population-level interventions. Lancet Planet Health 6:e858–e869.

74. NSC Research Center. 2023. Persistence and Retention ReportNational Student Clearinghouse.

75. Ghee M, Keels M, Collins D, Neal-Spence C, Baker E. 2016. Fine-tuning summer research programs to promote underrepresented students' persistence in the STEM pathway. CBE Life Sci Educ 15:1–11.

76. Nicholas Balster, Christine Pfund, Raelyn Rediske JB. 2010. Entering Research: A Course That Creates Community and Structure for Beginning Undergraduate Researchers in the STEM Disciplines. CBE Life Sci Educ 9:108–110.

77. Bindu GH, Srikanth V. 2019. Impact of Organizational Climate on Employee Turnover Intentions-An Empirical Study. IPE Journal of Management 9:1–13.

78. Stachl CN, Brauer DD, Mizuno H, Gleason JM, Francis MB, Baranger AM. 2021. Improving the Academic Climate of an R1 STEM Department: Quantified Positive Shifts in Perception. ACS Omega 6:14410–14419.

79. Stachl CN, Brauer DD, Mizuno H, Gleason JM, Rorrer JE, Francis MB, Baranger AM. 2021. Shaping the Future of Higher Education: Practical, Community-Driven Initiatives to Improve Academic Climate. ACS Cent Sci 7:910–916.

80. Tibbetts Y, Harackiewicz JM, Canning EA, Boston JS, Priniski SJ, Hyde JS. 2016. Affirming independence: Exploring mechanisms underlying a values affirmation intervention for first-generation students. J Pers Soc Psychol 110:635–659.

81. Allen-Ramdial SAA, Campbell AG. 2014. Reimagining the pipeline: Advancing STEM diversity, persistence, and success. Bioscience 64:612–618.

82. Office of Institutional Research and Analysis. Enrollment and Compound Annual Growth Rate | North Dakota State University.

83. Office of Institutional Research and Analysis. Semester Enrollment Summaries | North Dakota State University.

84. Office of Institutional Research and Analysis. Retention | North Dakota State University.

85. Pascarella ET. 1980. Student-Faculty Informal Contact and College OutcomesSource: Review of Educational Research. Winter.

86. Heo CY, Kim B, Park K, Back RM. 2022. A comparison of Best-Worst Scaling and Likert Scale methods on peer-to-peer accommodation attributes. J Bus Res 148:368–377.

87. DeVellis RF. 2016. Scale Development: Theory and Applications (Applied Social Research Methods), 4th ed.

88. Wilson M, Bathia S, Morell L, Gochyyev P, Koo BW, Smith R. 2022. Seeking a Better Balance Between Efficiency and Interpretability: Comparing the Likert Response Format With the Guttman Response Format. Psychol Methods 28:1358–1373.

89. Wilson M. 2023. Constructing Measures, 2nd ed. Routledge.

90. Butz AR, Branchaw JL. 2020. Entering research learning assessment (Erla): Validity evidence for an instrument to measure undergraduate and graduate research trainee development. CBE Life Sci Educ 19.

91. Handelsmman J, Pfund C, Miller Lauffer S, Maidl Pribbenow C. 2009. Entering Mentoring: A Seminar to Train a New Generation of Scientists, 1st ed.

92. Wilson ZS, Holmes L, deGravelles K, Sylvain MR, Batiste L, Johnson M, McGuire SY, Pang SS, Warner IM. 2012. Hierarchical Mentoring: A Transformative Strategy for Improving Diversity and Retention in Undergraduate STEM Disciplines. J Sci Educ Technol 21:148–156.

93. Oseguera L, Rhee BS. 2009. The Influence of Institutional Retention Climates on Student Persistence to Degree Completion: A Multilevel Approach.

94. Gray C, Wilcox G, Nordstokke D. 2017. Teacher Mental Health, School Climate, Inclusive Education and Student Learning: A Review. Canadian Psychology 58:203–210.

95. Committee of Effective Mentoring in STEMM, Board on Higher Education and Workforce, Policy and Global Affairs. 2019. The Science of Effective Mentorship in STEMM.

APPENDIX A. ND-ACES RTG SURVEY

ND-ACES Research Training Groups - Y3 Follow-Up Survey - 2023

Start of Block: Informed Consent

NORTH DAKOTA State University
Institutional Review Board
Study Information Sheet
Title of Project: ND-ACES: Research Training Groups for Students

Principle Investigator: Danielle Condry, Danielle.condry@ndsu.edu

Purpose of the Study
The purpose of this research study is to establish and evaluate the effectiveness of a vertically integrated support system—Research Training Group— at helping retain college students and promote their success as future STEM researchers.

Procedures to be Followed
This study is a multi-year study that will continue during your educational training in CCBSE research labs. Initially, you will be asked to provide demographic data via an online survey. Throughout the year, you will be invited to participate in a variety of activities with other students working in CCBSE labs. Bi-Annually, you will be asked to complete an online survey indicating your perceptions about those activities. Additionally, your number of presentations and/or publications will be recorded.

Risks
There are no risks in participating in this research beyond those experienced in everyday life. Because the research questionnaires request you to provide information about yourself that you may not want other people to know, there is a risk associated with the unlikely chance that somebody else might view the information you provide on your computer terminal. Therefore, you should protect yourself from these types of occurrences identified below: There is a possibility that your responses can be viewed by an outside party if you do not EXIT/CLOSE your Internet browser (e.g., Chrome, Firefox, Safari, etc.) as soon as you finish responding to the questionnaire. There is a possibility that your responses can be viewed by an outside party if you leave your browser on and leave the computer terminal before finishing the questionnaire (e.g., answer the phone, leave the computer unattended, etc.). In order to avoid inadvertent access to your responses by a third party, do not leave the terminal or stop responding to the questionnaire until you have completely finished and closed the browser.

Benefits
You might learn more about yourself as a researcher by participating in this study. You might have a better understanding of how important lab relationships are to developing scientists. You might realize that other students have had similar experiences as you have.

This research might provide a better understanding of how relationships affect college students.

This information could help plan student research programs, or make student research better experiences.

Duration
The Baseline and annual follow up survey is expected to take less than 20 minutes to complete.

Statement of Confidentiality
Your information will be kept completely confidential. Any identifying information will be kept separate from any of your survey answers. All information gathered will be aggregated across participants for any ND-ACES reports. Any information from this study that is published will not identify you by name.

All survey responses that we receive will be treated confidentially and stored on a secure server. However, given that the surveys can be completed from any computer (e.g., personal, work, school), we are unable to guarantee the security of the computer on which you choose to enter your responses. As a participant in our study, we want you to be aware that certain "key logging" software programs exist that can be used to track or capture data that you enter and/or websites that you visit.

Right to Ask Questions
The researcher conducting this study is Danielle Condry. If you have questions, concerns, or complaints about the research please contact Danielle Condry at Danielle.condry@ndsu.edu

You have rights as a research participant. If you have questions about your rights or questions about this research, you may talk to Danielle Condry, North Dakota State University, danielle.condry@ndsu.edu. You may also contact the NDSU Human Research Protection Program at 701.231.8995, ndsu.irb@ndsu.edu, or by mail at: NDSU HRPP Office, NDSU Dept. 4000, PO Box 6050, Fargo, ND 58108-6050.

Compensation
You will not receive compensation for your participation.

Voluntary Participation
You do not have to participate in this research. You can stop your participation at any time. You may refuse to participate or choose to discontinue participation at any time without losing any benefits to which you are otherwise entitled.
You do not have to answer any questions you do not want to answer. You must be 18 years of age older to participate in this research study. Completion of this survey implies that you have read the information in this form and consent to participate in the research. Please keep this form for your records or future reference. **Thank you for your participation and please click the next button to complete the survey.**

The following information is collected so that we can follow your progression through the Research Training Groups. This information will be separated from the survey data and replaced with a randomly generated code to ensure confidentiality. The list of codes will be kept in a separate password protected and encrypted file and only the Primary Investigators will have access to it. You can be assured that your responses will remain confidential and any dissemination of findings will be entirely anonymous.

What is your name?

_____

What is your school email address?

_____

End of Block: Informed Consent

Start of Block: Professional/Technical Skills Set 1

Please rate your current ability to do the following:

	Choose one of the following				
	Minimal	Fair	Moderate	Good	Extensive
Using tools, instruments, and/or techniques in my lab	○	○	○	○	○
Figuring out what data needs to be collected and how to collect it	○	○	○	○	○
Understanding basic data analysis techniques	○	○	○	○	○
Creating an analytical plan to interpret data	○	○	○	○	○
Understanding basic biomedical sciences review procedures	○	○	○	○	○
Creating meaningful explanation for results of a study including limitations and alternative explanations	○	○	○	○	○

End of Block: Professional/Technical Skills Set 1

Start of Block: Professional/Technical Skills Set 2

Please rate your current ability to do the following:

	Choose one of the following:				
	Minimal	Fair	Moderate	Good	Extensive
Using scientific literature and/or reports to guide my research	○	○	○	○	○
Planning out a research project	○	○	○	○	○
Developing testable and realistic research questions	○	○	○	○	○
Developing theories that integrate and coordinate results from multiple studies	○	○	○	○	○
Working in collaboration with others on research	○	○	○	○	○
Creating data presentations and visualizations (tables, graphs, etc.)	○	○	○	○	○

End of Block: Professional/Technical Skills Set 2

Start of Block: Professional/Technical Skills Set 3

Please rate your current ability to do the following:

	Choose one of the following:				
	Minimal	Fair	Moderate	Good	Extensive
Reporting research results in a written paper	○	○	○	○	○
Presenting research orally	○	○	○	○	○
Working with members from other disciplines and organizations on shared research projects	○	○	○	○	○
Making decisions and solving problems in a timely fashion	○	○	○	○	○
Adhering to ethics in research	○	○	○	○	○

End of Block: Professional/Technical Skills Set 3

Start of Block: Self-efficacy Set 1

Indicate the level of confidence in your ability to do the following:

	Choose one of the following:					
	Not at all confident	Beginner	Advanced Beginner	Basic Competence	Proficient	Absolutely Confident
Use technical skills (use of tools, instruments, and/or techniques).	○	○	○	○	○	○
Use scientific language and terminology.	○	○	○	○	○	○
Generate a research question to answer.	○	○	○	○	○	○
Figure out what data to collect and how to collect them.	○	○	○	○	○	○
Figure out/analyze what data mean.	○	○	○	○	○	○
Create explanations for the results of the study.	○	○	○	○	○	○
Use scientific literature and/or reports to guide research.	○	○	○	○	○	○

End of Block: Self-efficacy Set 1

Start of Block: Self-efficacy Set 2

Indicate the level of confidence in your ability to do the following:

	Choose one of the following:					
	Not at all confident	Beginner	Advanced Beginner	Basic Competence	Proficient	Absolutely Confident
Relate results and explanations to the work of others.	○	○	○	○	○	○
Develop theories (integrate and coordinate results from multiple studies).	○	○	○	○	○	○
Report research results in an oral presentation.	○	○	○	○	○	○
Report research results in a written paper.	○	○	○	○	○	○
Understand the ethics of research.	○	○	○	○	○	○
Generally, function as a scientist in research activity.	○	○	○	○	○	○
Learn the full range of science skills with appropriate training.	○	○	○	○	○	○

End of Block: Self-efficacy Set 2

Start of Block: Self-Efficacy Set 3

Thinking of future work, how well can you...

	Not very well at all (1) to Very Well (5)				
	1	2	3	4	5
achieve goals that will be assigned	○	○	○	○	○
respect schedules and working deadlines	○	○	○	○	○
learn new working methods	○	○	○	○	○
concentrate all energy on work	○	○	○	○	○
finish assigned work	○	○	○	○	○
collaborate with your mentor and peers in the research lab	○	○	○	○	○
work with people of diverse experiences and ages	○	○	○	○	○
have a good relationship with direct superiors	○	○	○	○	○
behave in an efficacious way with peers	○	○	○	○	○
work in a team	○	○	○	○	○

End of Block: Self-Efficacy Set 3

Start of Block: Persistence intentions

I am a/an

- ○ Undergraduate student
- ○ Graduate student

Undergraduate students, please indicate your level of agreement to the following statements:

	Choose one of the following:				
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I intend to learn more about graduate programs in scientific research in the future.	○	○	○	○	○
I intend to apply to graduate programs in scientific research in the future.	○	○	○	○	○
My goal is to be accepted into a graduate program in scientific research in the future.	○	○	○	○	○
I intend to continue my education in scientific research beyond my undergraduate degree.	○	○	○	○	○

Graduate students, please indicate your level of agreement to the following statements:

	Choose one of the following:				
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I intend to continue my/pursue a PhD in scientific research.	○	○	○	○	○
I intend to pursue a career in scientific research.	○	○	○	○	○
I intend to pursue a career in academia (research and teaching).	○	○	○	○	○

End of Block: Persistence intentions

Start of Block: Sense of Belonging

Please indicate your level of agreement to the following statements:

	Please choose one of the following.						
	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I am well-accepted by others in the lab.	○	○	○	○	○	○	○
When in the lab, I really feel like I belong.	○	○	○	○	○	○	○
I feel like I just don't fit in in the lab.	○	○	○	○	○	○	○
I feel quite isolated from others in the lab.	○	○	○	○	○	○	○

End of Block: Sense of Belonging

Start of Block: Block 11

During the past year (Fall 2022-Spring 2023) I participated in: (select all that apply)

- [ ] Monthly ND-ACES Journal Club via Teams
- [ ] Journal Club in my local department
- [ ] Monthly ND-ACES Professional Development Sessions via Teams
- [ ] Professional Development Sessions at my local college/university
- [ ] ND-ACES Mentoring Program
- [ ] Mentoring Program at my local department/college/university
- [ ] None of the above

End of Block: Block 11

Start of Block: Demographic Questions

In this section of the survey, you will be given the option to report demographic information about yourself, but you do not have to answer these questions (they are completely optional). We will only aggregate the data for large areas (race separately), and will not cross aggregate (race x gender) as we feel that may make the survey less anonymous. Please note that we are asking this demographic questions so that we can bolster the mentoring experiences and retention of bioscience students as one way to broaden the participation in the field.

What sex where you assigned at birth?

- ○ Male
- ○ Female
- ○ Intersex

How do you describe your gender identity?

- ○ Woman
- ○ Man
- ○ Genderqueer
- ○ Gender nonbinary
- ○ Intersex, two spirit
- ○ Different gender identity not included above. Please specify

_____

Are you Hispanic or Latinx origin?

- ○ Yes
- ○ No

How do you describe your race? (select all that apply)

- [ ] American Indian, Alaska Native, Native American, or Indigenous
- [ ] Asian
- [ ] Black or African American
- [ ] Middle Eastern or North African
- [ ] White
- [ ] Different racial identity not included above. Please Specify.

_____

Please describe your tribal affiliation and/or ethnicity (e.g., Lakota, Dakota, Chinese, Korean, Ethiopian, Haitian, Mexican, Puerto Rican, Lebanese, Algerian, Native Hawaiian, Samoan, German, Irish)

_____

How old are you in years?

_____

How would you describe your sexual orientation?

- ○ Asexual
- ○ Bisexual
- ○ Demisexual
- ○ Fluid
- ○ Gay
- ○ Heterosexual
- ○ Lesbian
- ○ Pansexual
- ○ Queer
- ○ Questioning
- ○ Different sexual orientation not listed above. Please specify.

_____

What is your relationship status?

- ○ Divorced
- ○ Married
- ○ Separated
- ○ Single
- ○ Widowed
- ○ Different relationship status not listed above. Please specify.

_____

Do you consider yourself a member of a group that is a minority or underrepresented in the STEM fields (based on gender, race, and/or ethnicity)?

- ○ Yes
- ○ No

What type of student are you?

- ○ Undergraduate student
- ○ Graduate student - Masters
- ○ Graduate student - Doctoral
- ○ Other. Please specify. _____

Do you consider yourself a "first-generation" student. (First generation = your parent(s) did not complete a 4-year college or university degree).

- ○ Yes
- ○ No
- ○ Not sure

Do you consider yourself an “international” student? For example, born and raised outside of USA.

- ○ Yes
- ○ No

What is your primary academic field of study?

_____

What is your secondary academic field of study (if applicable)?

_____

What is the highest degree you have earned?

- ○ High school diploma
- ○ Associates degree
- ○ Bachelors degree
- ○ Masters degree
- ○ Doctoral degree
- ○ Other

End of Block: Demographic Questions

Start of Block: Debriefing

Thank you for taking the survey!

Thank you for taking the survey! Your responses will be pooled with those of other participants and examined as a group. The questions to which you responded were created to measure your perceptions of your professional/technical skills along with work-related confidence, engagement, satisfaction, and persistence in engineering fields. This information was gathered as a part of the ND-ACES Education and Workforce Development project metrics. We hope to publish and present the research and use it to create and improve workplaces for early career biosciences faculty.

End of Block: Debriefing

APPENDIX B. DEPARTMENT OF MICROBIOLOGICAL SCIENCES CLIMATE SURVEY

NDSU Microbiology/Biotechnology Climate Survey

Key information about this study: This consent form is designed to inform you about the study you are being asked to participate in. You are being invited to participate in a research study about the climate in the Department of Microbiological Sciences at North Dakota State University. The study consists of several questions and should take no more than 20 minutes to complete. There are no expected risks associated with this study. The benefits are contributing to improvement of the climate in the Microbiological Sciences Department. Your participation is voluntary, identifying demographic information will be protected, and records of this study will be kept private.

Why am I being asked to take part in this study?
The purpose of this study is to gain an understanding of the current climate the Department of Microbiological Sciences at North Dakota State University.

What will I be asked to do?
You will be asked to answer questions about your experiences, opinions, and ideas concerning the current climate in the Department of Microbiological Sciences at North Dakota State University. You will also be asked to answer several demographic questions.

Where is the study going to take place, and how long will it take?
The study will take place online and should take no longer than 20 minutes to complete.

What are the risks and discomforts?
There are no anticipated physical/psychological risks associated with participation in this study beyond those experienced in everyday life.
Because the research questionnaires request you to provide information about yourself that you may not want other people to know, there is a risk associated with the unlikely chance that somebody else might view the information you provide on your computer terminal.
Therefore, you should protect yourself from these types of occurrences identified below: There is a possibility that your responses can be viewed by an outside party if you do not EXIT/CLOSE your Internet browser (e.g., Chrome, Firefox, Safari, etc.) as soon as you finish responding to the questionnaire. There is a possibility that your responses can be viewed by an outside party if you leave your browser on and leave the computer terminal before finishing the questionnaire (e.g., answer the phone, leave the computer unattended, etc.). In order to avoid inadvertent access to your responses by a third party, do not leave the terminal or stop responding to the questionnaire until you have completely finished and closed the browser.

What are the expected benefits of this research?

Individual Benefits: Improved climate in the Department of Microbiological Sciences at North Dakota State University.
Societal Benefits: This study may benefit others by improving the climate of the Department of

Microbiological Sciences at North Dakota State University but also improve our understanding of implemented measures to improve climate.

Do I have to take part in this study?
Taking part in this research study is entirely up to you. You may choose not to participate, or you may discontinue your participation at any time without penalty.

What are the alternatives to being in this study?
Instead of being in this research, you may choose not to participate.

Who will have access to my information?
The records of this study will be kept private. Please recognize that we are using a web survey to collect data and have taken all reasonable measures to protect your identity and responses. For example, the data is SSL encrypted, it is stored on a password protected database, and IP addresses are not collected. Information entered into the database will be accessible only to those listed on the IRB for this study. In any published report or presentation of the results, we will not include any information that will make it possible to identify any participant. All information gathered will be aggregated across participants. Any information from this study that is published will not identify you by name.

However, given that the surveys can be completed from any computer (e.g., personal, work, school), we are unable to guarantee the security of the computer on which you choose to enter your responses. As a participant in our study, we want you to be aware that certain "key logging" software programs exist that can be used to track or capture data that you enter and/or websites that you visit.

Can my participation in the study end early?
If you decide to participate in the study, you may change your mind and stop participating at any time without penalty or loss of benefits to which you are already entitled.

Will I receive any compensation for participating in the study?
There is no compensation for participating in the study.

What if I have questions?
If you have questions about the study, you can contact Danielle Condry at danielle.condry@ndsu.edu

What are my rights as a research participant?
You have rights as a research participant. All research with human participants is reviewed by a committee called the *Institutional Review Board (IRB)* which works to protect your rights and welfare. If you have questions about your rights, an unresolved question, a concern or complaint about this research you may contact the IRB office at 701.231.8995, toll-free at 855-800-6717 or via email (ndsu.irb@ndsu.edu).

Documentation of Informed Consent:
You are freely making a decision whether to be in this research study. Clicking 'I agree' to this

form means that
1. you have read and understood this consent form
2. you have had your questions answered, and
3. you have decided to be in the study

By clicking "I agree" I am providing my consent to participate in this study.

- ○ I agree (1)
- ○ I decline (2)

Skip To: End of Survey If By clicking "I agree" I am providing my consent to participate in this study. = I decline

Page Break

I am a current:

- ○ Undergraduate Student (1)
- ○ Graduate Student (2)
- ○ Staff Member (3)
- ○ Research Faculty Member (4)
- ○ Teaching Faculty Member (5)

End of Block: Intro

Start of Block: Undergraduate Identifying information

What year are you in your program?

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5+ (5)

What is your current cumulative GPA?

- ○ (1)
- ○ 2.00-2.49 (2)
- ○ 2.50-2.99 (3)
- ○ 3.00-3.49 (4)
- ○ 3.50-3.99 (5)
- ○ 4.0 (6)

What is your major? (Select all that apply)

- ☐ Biotechnology (1)
- ☐ Microbiology (2)
- ☐ Microbiology Pre-veterinary medicine (3)

End of Block: Undergraduate Identifying information

Start of Block: Student Climate

In general, I feel that...

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I have access to the resources I need to be successful (1)	○	○	○	○	○
I feel welcome and included in my department (2)	○	○	○	○	○
I feel welcome and included in the College of Agriculture, Food Science, and Natural Resources (3)	○	○	○	○	○
I am satisfied with my learning environment in the classroom (4)	○	○	○	○	○

I feel comfortable...

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Speaking with my advisor(s) about non-academic career paths (1)	○	○	○	○	○
Disclosing mental and/or physical health conditions that may impact my work to my advisor(s) (2)	○	○	○	○	○
Seeking feedback and/or advice on my work from other faculty (3)	○	○	○	○	○
Attending and participating in social events hosted by my department (4)	○	○	○	○	○

Please rate the quality of teaching you have experienced in the department of Microbiological Sciences:

- ○ 0 (0)
- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)
- ○ 6 (6)
- ○ 7 (7)
- ○ 8 (8)
- ○ 9 (9)
- ○ 10 (10)

Please explain your reasoning for your ranking.

_____

Please rate your perception of your school-life balance:

- ○ 0 (0)
- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)
- ○ 6 (6)
- ○ 7 (7)
- ○ 8 (8)
- ○ 9 (9)
- ○ 10 (10)

Please explain your reasoning for your ranking.

_____

Please rate, on average, the interactions you have had with the following individuals:

	Poor (1)	Below Average (2)	Average (3)	Good (4)	Excellent (5)
Faculty in your department (1)	○	○	○	○	○
Instructor(s) (2)	○	○	○	○	○
Advisor(s) (3)	○	○	○	○	○
Peers in your program (4)	○	○	○	○	○
Staff (5)	○	○	○	○	○

Please define what success looks like for you in your education and preparation for your future career:

_____

Are you working (paid or unpaid) in a research program/lab at NDSU?

- ○ Yes (2)
- ○ No (1)

Display This Question:

If I am a current: = Undergraduate Student

And Are you working (paid or unpaid) in a research program/lab at NDSU? = Yes

What department do you do research in?

- ○ Agribusiness and Applied Economics (1)
- ○ Agricultural and Biosystems Engineering (2)
- ○ Animal Sciences (3)
- ○ Microbiological Sciences (4)
- ○ Plant Pathology (5)
- ○ Plant Sciences (6)
- ○ School of Natural Resources Sciences (7)
- ○ Youth Development, Family and Agricultural Education (8)
- ○ Other (9) _____

Display This Question:

If I am a current: = Undergraduate Student

And Are you working (paid or unpaid) in a research program/lab at NDSU? = Yes

Or I am a current: = Graduate Student

I feel that my research advisor(s)

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Is/are easy to talk to about my research (1)	○	○	○	○	○
Is/are available when I need advice concerning my research (2)	○	○	○	○	○
Provide(s) constructive feedback on my research project (3)	○	○	○	○	○
Treat(s) my ideas with respect (4)	○	○	○	○	○
Encourage(s) me to attend and present at conferences (5)	○	○	○	○	○

Display This Question:

If I am a current: = Undergraduate Student

And Are you working (paid or unpaid) in a research program/lab at NDSU? = Yes

Or I am a current: = Graduate Student

In general, I believe that

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Publishing academic papers is an important metric of my own success (1)	○	○	○	○	○
Publishing academic papers is the primary metric my advisor uses to gauge my success (2)	○	○	○	○	○
Publishing academic papers should be the primary metric used to gauge graduate student success (3)	○	○	○	○	○
The impact of a publication is more important than the number of publications (4)	○	○	○	○	○

Display This Question:

If I am a current: = Undergraduate Student

And Are you working (paid or unpaid) in a research program/lab at NDSU? = Yes

Or I am a current: = Graduate Student

Please define what success looks like for you in your current research role.

_____

Display This Question:

If I am a current: = Undergraduate Student

And Are you working (paid or unpaid) in a research program/lab at NDSU? = Yes

Or I am a current: = Graduate Student

I feel that my research advisor(s)

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Advocate(s) for me when appropriate (1)	○	○	○	○	○
Provide(s) emotional support when necessary (2)	○	○	○	○	○
Provide(s) non-research advice when necessary (3)	○	○	○	○	○
Foster(s) a collaborative environment with minimal competition between group members (4)	○	○	○	○	○

In my opinion, in my department, I believe that...

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Exclusionary or offensive behavior is not tolerated (1)	○	○	○	○	○
Harassment of any kind is not tolerated (2)	○	○	○	○	○
There is sufficient discussion of equity and inclusion (3)	○	○	○	○	○
There is sufficient action toward improving equity and inclusion (4)	○	○	○	○	○

As a member of my department, I feel that

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
There are faculty members other than my advisor(s) who are available to me when I need advice (1)	○	○	○	○	○
I know who to talk with about any concerns regarding the departmental climate (2)	○	○	○	○	○
Members of the department that identify as minorities feel valued and are included (3)	○	○	○	○	○
I am valued and included as a member of the department (4)	○	○	○	○	○

In this survey, we use the NSF solicitation definition of underrepresented groups (URGs) in STEM: “Groups underrepresented in STEM may include but are not limited to: women and girls,

individuals with disabilities, underrepresented racial and ethnic minorities (e.g., African Americans, Hispanics, Native Americans, Alaska Natives, Native Hawaiians, and Pacific Islanders), English-language learners, veterans and students from rural or lower socio-economic backgrounds."

Please indicate how important it is to you personally that your department take action in each of the following issues:

	Not important (1)	Somewhat important (2)	Very important (3)	Prefer not to answer (0)
Increasing retention of graduate students from URGs (1)	○	○	○	○
Educating members of the department about the representation and compensation of URG members in STEM (2)	○	○	○	○
Educating members of the department about biases and behaviors that negatively affect the experiences of URG members (3)	○	○	○	○

Are there any particular actions you would like the college or department to take in order to enhance the environment or climate for all students? Please be specific.

_____

Page Break

Is there anything else you would like to share about the departmental or college climate you would like to see addressed?

_____

Page Break

End of Block: Student Climate

Start of Block: Demographics

Do you consider yourself a member of a URG?

- ○ Yes (2)
- ○ No (1)

What is your gender identity?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (5)
- ○ Other (4)

What is your race/ethnicity? Select all that apply:

- ☐ White (1)
- ☐ Black or African American (2)
- ☐ Hispanic/Latinx (3)
- ☐ Native Hawaiian or Pacific Islander (4)
- ☐ Asian (5)
- ☐ Native American (6)
- ☐ Prefer not to answer (7)
- ☐ Other (8)

Is English your first or preferred language? If not, please indicate what is.

- ○ Yes (2)
- ○ No: (1) _____

Are you a US citizen?

- ○ Yes (2)
- ○ No (1)

Do you identify as a caretaker (of children or other family members)?

- ○ Yes (2)
- ○ No (1)

The ADA definition of disability is a person with physical or mental impairments that substantially limit one or more major life activities. Do you identify as a person with a disability or other chronic condition?

- ○ Yes (1)
- ○ No (2)
- ○ Prefer not to answer (3)

Display This Question:

If The ADA definition of disability is a person with physical or mental impairments that substantial... = Yes

How would you describe your disability or chronic condition? Select all that apply.

- ☐ Attention deficit (1)
- ☐ Autism (2)
- ☐ Blind or visually impaired (3)
- ☐ Deaf or hard of hearing (4)
- ☐ Health-related disability (5)
- ☐ Learning disability (6)
- ☐ Mental health condition (7)
- ☐ Mobility-related disability (8)
- ☐ Speech-related disability (9)
- ☐ Other (please specify, optional) (10) _____

In the last year, have you ever struggled with food insecurity (lack of consistent access to enough food)?

- ○ Yes (2)
- ○ No (1)
- ○ Prefer not to answer (3)

What is your current age range?

- ○ 18-20 (1)
- ○ 21-25 (2)
- ○ 26-30 (3)
- ○ 31-35 (4)
- ○ 36-40 (5)
- ○ 41-49 (6)
- ○ 50+ (7)

End of Block: Demographics

Start of Block: Undergrad Demographic Qs

Are you a part-time or full-time student?

- ○ Part-time (1)
- ○ Full-time (2)

Are you a first-generation student?

- ○ Yes (2)
- ○ No (1)

Are you a pell-eligible student?

- ○ Yes (2)
- ○ No (1)
- ○ Unsure (3)

Are you currently working?

- ○ Yes, 0-10 hours/week (2)
- ○ Yes, 10-20 hours/week (3)
- ○ Yes, 20-30 hours/week (4)
- ○ Yes, 30+ hours/week (5)
- ○ No (1)

End of Block: Undergrad Demographic Qs

Start of Block: Graduate Identifying information

I am a...

- ○ Master's student (1)
- ○ Doctoral student (2)
- ○ Non-degree seeking student (3)

What year are you in your program?

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)
- ○ 6+ (6)

Are you currently working outside of your assistantship?

- ○ Yes, 0-10 hours/week (2)
- ○ Yes, 10-20 hours/week (3)
- ○ Yes, 20-30 hours/week (4)
- ○ Yes, 30+ hours/week (5)
- ○ No (1)

End of Block: Graduate Identifying information

Start of Block: Faculty/Staff climate

In general, I feel that

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I have access to the resources I need to be successful (1)	○	○	○	○	○
I feel welcome and included in my department (2)	○	○	○	○	○
I feel welcome and included in the College of Agriculture, Food Science, and Natural Resources (3)	○	○	○	○	○
I am connected to the work that I do (4)	○	○	○	○	○
I am recognized for my work and contributions (5)	○	○	○	○	○
I am valued by my department (Microbiological Sciences) (6)	○	○	○	○	○
I am valued by my college (CAFSNR) (7)	○	○	○	○	○
My leaders and managers are transparent (8)	○	○	○	○	○
My work schedule is flexible enough to meet family and personal responsibilities (9)	○	○	○	○	○

Please rate your perception of your work-life balance:

- ○ 0 (0)
- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)
- ○ 6 (6)
- ○ 7 (7)
- ○ 8 (8)
- ○ 9 (9)
- ○ 10 (10)

Please explain your reasoning for your ranking.

_____

I believe that I...

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Am available to my students when they need advice concerning their research (1)	○	○	○	○	○
Foster a collaborative environment where competition between group members is minimal (2)	○	○	○	○	○
Am comfortable directing my students to resources on campus concerning mental and physical health issues when necessary (3)	○	○	○	○	○

In general, I believe...

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Academic publication record is the primary metric I use to gauge my mentee's success (1)	○	○	○	○	○
That publishing academic papers is an important metric of my own success (2)	○	○	○	○	○
That the impact of a publication is more important than the number of publications (3)	○	○	○	○	○

Display This Question:

If I am a current: != Undergraduate Student

And I am a current: != Graduate Student

And I am a current: != Staff Member

Please define what you think success looks like for your students in your classroom.

_____

Display This Question:

If I am a current: != Undergraduate Student

And I am a current: != Graduate Student

And I am a current: != Teaching Faculty Member

Please define what you think success looks like for research students. If not applicable, please respond "NA"

_____

Please define what success looks like for you in your current role.

_____

In general, in my department, I feel:

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Comfortable asking for advice and/or feedback from my colleagues when appropriate (1)	○	○	○	○	○
A sense of mutual respect between department colleagues (2)	○	○	○	○	○
That department members cooperate and collaborate (3)	○	○	○	○	○

In my opinion, in my department:

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Exclusionary or offensive behavior is not tolerated (1)	○	○	○	○	○
Harassment of any kind is not tolerated (2)	○	○	○	○	○
There is sufficient discussion of equity and inclusion (3)	○	○	○	○	○
There is sufficient action toward improving equity and inclusion (4)	○	○	○	○	○

In this survey, we use the NSF solicitation definition of underrepresented groups (URGs) in STEM: “Groups underrepresented in STEM may include but are not limited to: women and girls, individuals with disabilities, underrepresented racial and ethnic minorities (e.g., African Americans, Hispanics, Native Americans, Alaska Natives, Native Hawaiians, and Pacific S16 Islanders), English-language learners, veterans and students from rural or lower socio-economic backgrounds.”

In general, in the Department of Microbiology, I feel that

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I am valued and included as a member of the department (1)	○	○	○	○	○
Members of the department who identify as minorities feel valued and are included (2)	○	○	○	○	○
I know who to talk with about concerns regarding the departmental climate (3)	○	○	○	○	○

Please indicate how important it is to you personally that your department improve recruitment of _____ who are members of URGs:

	Not important (1)	Somewhat important (2)	Very important (3)
Undergraduate students (1)	○	○	○
Graduate students (2)	○	○	○
Postdoctoral researchers (3)	○	○	○
Faculty (4)	○	○	○
Staff (5)	○	○	○

Please indicate how important it is to you personally that your department take action in each of the following issues:

	Not important (1)	Somewhat important (2)	Very important (3)
Increasing retention of graduate students from URGs (1)	○	○	○
Educating members of the department about the representation and compensation of URG members in STEM (2)	○	○	○
Educating members of the department about biases and behaviors that negatively affect the experiences of URG members (3)	○	○	○

Are there any particular actions you would like the college or department to take in order to enhance the environment or climate for all faculty and/or staff? Please be specific.

_____

Is there anything else you would like to share about the departmental or college climate you would like to see addressed?

_____

End of Block: Faculty/Staff climate

Start of Block: Staff only

Display This Question:

If I am a current: = Staff Member

What is your current staff position?

- ○ Full-time (1)
- ○ Part-time (2)
- ○ Adjunct (3)

Display This Question:

If I am a current: = Staff Member

What is your highest completed degree?

- ○ High school diploma or equivalent (1)
- ○ Associate degree (2)
- ○ Bachelor's degree (3)
- ○ Master's degree (4)
- ○ PhD (5)

End of Block: Staff only

Start of Block: Faculty/staff only

Display This Question:
If I am a current: = Research Faculty Member
Or I am a current: = Staff Member
Or I am a current: = Teaching Faculty Member

How many years have you been at NDSU?

- ○ Six Years or Less (1)
- ○ More then six years (2)

End of Block: Faculty/staff only

Start of Block: Faculty only

Display This Question:
If I am a current: = Research Faculty Member
Or I am a current: = Teaching Faculty Member

What is your current faculty position?

- ○ Tenure Track (1)
- ○ Tenured (2)
- ○ Non-tenure track (3)

End of Block: Faculty only