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SUCCESS (Studying Underlying Characteristics of Computing and Engineering Student Success) Survey: Non-Cognitive and Affective Profiles in Engineering and Computing Students at UTEP (2018-2022)

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SUCCESS (STUDYING UNDERLYING CHARACTERISTICS OF COMPUTING AND ENGINEERING STUDENT SUCCESS) SURVEY

NON-COGNITIVE AND AFFECTIVE PROFILES IN ENGINEERING AND COMPUTING STUDENTS AT UTEP (2018-2022)



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Introduction

The University of Texas at El Paso (UTEP), Purdue, and California Polytechnic State University (Cal Poly) collaborated to understand how non-cognitive, and affective (NCA) factors, defined as personality and other innate characteristics and behaviors), impact the academic performance of undergraduates engineering and computing students. Understanding the relationship is important, as it allows faculty, staff, and administrators to better understand the mechanisms of success and failure among the students in engineering and computing fields. In addition, the multi-institution research team pointed out that predictive models for the student's academic outcomes mainly rely upon students' cognitive factors such as high school GPA, SAT scores, and similar measures of cognitive performance. Most recent research includes NCA factors to improve the predictive power of academic performance models in engineering and computing fields; however, significant gaps remain in our understanding of the relationships between NCA profiles, student academic performance, and support system for student college success ("The SUCCESS Project," 2023).

The multi-institution research team developed the SUCCESS (Studying Underlying Characteristics of Computing and Engineering Student Success) survey to examine underlying factors that may contribute to students' college success, such as personality, grit, engineering/computing identity, mindset, motivation, perceptions of faculty caring, stress, belongingness, stress, and mindfulness (Berger et al., 2018). The validity evidence has been established for the SUCCESS survey using Exploratory Factor Analysis (EFA); the team evaluated the survey instrument and determined survey items included in the national release of the survey in the Fall of 2017. They also used Confirmatory factor analysis (CFA) on the 28 NCA factors included in the survey with a national sample. The team improved the measurements using CFA and reduced the survey length (Scheidt et al., 2018).

Survey Administration

UTEP administered the SUCCESS survey that measures 28 NCA factors from Spring 2018 through Spring 2022. In Spring 2018 and 2019, the paper-version survey was given to primary students taking selected introductory courses across seven departments in the College of Engineering at UTEP. The UTEP research team selected different courses in the Engineering Education & Leadership and Industrial and Manufacturing &

Systems Engineering department depending upon the availability (See the table below). In Spring 2018, 304 students completed the survey; in Spring 2019, 305 students completed the survey. In the Spring 2020 semester, UTEP was scheduled to administer the survey to the students in the College of Engineering; however, the delivery date changed to the fall 2020 semester because of the pandemic. Therefore, in the Fall of 2020, UTEP administered an online version of the survey by sending out a survey invitation to the students taking the selected courses. As a result, 108 students completed the electronic survey, and the response rate of approximately 18%, which was low compared to the response rates in the Spring of 2018 and 2019.

Table 1. Selected Courses by Survey Administration Year

Department	Selected Courses			
	Spring 2018, 2019	Fall 2020	Spring 2021	Spring 2022
Civil Engineering	CE 1301. Civil Engineering Fundamentals			
Computer Science	CS 1301. Intro to Computer Science			
Electrical and Computer Engineering	EE 1305. Intro Electrical and Computer Engineer			
Engineering Education & Leadership	EL 1302. Intro to Engineering Design and Leadership (Design Nature)	EL 1405. Fundamentals of Engineering Leadership and Graphics	EL 1405. Fundamentals of Engineering Leadership and Graphics	EL 1402. Fundamentals of Leadership, Design & Graphics
Industrial, Manufacturing & Systems Engineering	IE 3331. Systems Engineering	IE 2377. Electro-Mechanical Systems		
Mechanical Engineering	MECH 1305. Graphic & Design Fundamentals			
Metallurgical, Materials, & Biomedical Engineering	MME 2303. Introduction to Materials Science & Engineering			

In Spring 2021 and 2022, one of the UTEP research team visited each class virtually or in-person to debrief and administer an online version survey. As a result, the survey completion rate increased; 270 students in Spring 2021 and 188 students in Spring 2022 completed the survey.

Along with self-reported demographics in the survey questionnaire, student survey responses were linked to portions of student academic records and the Dean of Student's record to examine relationships among the survey responses and academic and non-academic outcomes. These specific data include academic transcript data; admission application data; demographic information; conduct records; and eligibility for financial aid. After connecting student survey responses to the records and cleaning the survey data sets, the analytical sample are the following: Spring 2018 (N = 291), Spring 2019 (n = 250), Fall 2020 (n = 119), Spring 2021 (n = 232), and Spring 2022 (n = 228).

About the Survey Analysis

This report examines the averages of student reports of NCA profiles in engineering and computing fields at UTEP. This report is guided by a research question: To what extent do the NCA profiles vary by student demographics, particularly gender, sexual minority status, age, first-generation college status, transfer status, and employment status during college? This report only highlights differences in group averages when they are statistically and significantly different between two or three groups. Two-sided t-tests are used to test the mean differences between the two groups. For comparison with more than two groups, one-way analysis of variance (ANOVA) was conducted with the post-estimation pairwise comparison with the Tukey-Kramer method for multiple comparisons and unequal sample size within a group.

In several domains, similar survey items are used together to create a scale called "composite measure" to best capture and construct an underlying concept. For instance, three survey items (i.e., get upset easily, change my mood a lot, have frequent mood swings) were used to create the scale "Neuroticism," one of the big five personalities. Using composite measures is recommended with survey data because the scale provides a better way to measure a concept than an individual/single item. To create each of the 28 NCA factors, the UTEP research team used the same survey items that were validity tested and constructed by the multi-institution research team. The survey topics and items are in the following section.

Survey Topics and Survey Items

#	Construct	Topic	Survey Item
1	Big Five personality	Neuroticism	Get upset easily.
			Change my mood a lot.
			Have frequent mood swings.
		Extraversion	Don't talk a lot.
			Keep in the background.
			I am quiet around strangers.
		Agreeableness	Sympathize with others' feelings.
			Have a kind heart.
			Feel others' emotions.
		Conscientiousness	Leave my belongings around.
			Make a mess of things.
			Often forget to put things back in their proper places.
		Openness	Have a vivid imagination.
			Have excellent ideas.
			Am full of ideas.
2	Grit	Consistency of interest	New ideas and projects sometimes distract me from old ones.
			I have been obsessed with a certain idea or project for a short time but later lost interest.
			I often set a goal but later choose to pursue a different one.
			I have difficulty maintaining my focus on projects that take more than a few months to complete.
3	Engineering identity	Recognition	My parents see me as an engineer.
			My instructors see me as an engineer.
			My peers see me as an engineer.
		Interest	I have had experiences in which I was recognized as an engineer.
			I am interested in learning more about engineering.
			I enjoy learning engineering.

			I find fulfillment in doing engineering.
4	Mindset	Mindset	<p>I can learn new things, but I don't have the ability to change my basic intelligence.</p> <p>To be honest, I don't think I can really change how intelligent I am.</p> <p>Regardless of my current intelligence level, I think I have the capacity to change it quite a bit.</p> <p>With enough time and effort, I think I could significantly improve my intelligence level.</p> <p>I believe I can always substantially improve on my intelligence.</p> <p>I believe I have the ability to change my basic intelligence level considerable over time.</p>
5	Mindfulness	Mindfulness	<p>It seems that I am "running on automatic," without much awareness of what I'm doing.</p> <p>I rush through activities without being really attentive to them.</p> <p>I do jobs or tasks automatically, without being aware of what I'm doing.</p> <p>I find myself doing things without paying attention.</p>
6	Meaning and Purpose	Meaning and Purpose	<p>My life has a clear sense of purpose.</p> <p>I have found a satisfactory meaning in life.</p> <p>I know what gives meaning to my life</p>
7	Belongingness	Belongingness	<p>I feel comfortable in engineering.</p> <p>I feel I belong in engineering.</p> <p>I enjoy being in engineering.</p> <p>I feel comfortable in my engineering classes.</p>
8	Gratitude	Gratitude	<p>I feel thankful for the opportunity to learn so many new things</p> <p>I appreciate the things I have learned in my college classes</p> <p>I am grateful to the professors and other students who have helped me in class</p> <p>If I had to list everything I felt grateful for about my academic experience at my university, it would be a very long list</p>
9	Future Time Perspective – Motivation	Expectancy	<p>I expect to do well in my engineering classes.</p> <p>I am certain I can master the skills being taught in my engineering classes.</p> <p>I believe I will receive an excellent grade in my engineering classes.</p>

			<p>I am confident I can do an excellent job on the assignments in my engineering classes.</p> <p>Considering the difficulty of my engineering classes, the teacher, and my skills, I think I will do well in my engineering classes.</p>
		Connectedness	<p>I don't think much about the future.</p> <p>I don't like to plan for the future.</p> <p>One shouldn't think too much about the future.</p> <p>Planning for the future is a waste of time.</p>
		Instrumentality	<p>I will use the information I learn in my engineering classes in other classes I will take in the future.</p> <p>I will use the information I learn in engineering classes in the future.</p> <p>What I learn in my engineering classes will be important for my future occupational success.</p>
		Value	<p>Long range goals are more important than short range goals.</p> <p>What happens in the long run is more important than how one feels right now.</p>
		Perception	<p>I am confident about my choice of major.</p> <p>Engineering is the most rewarding future career I can imagine for myself.</p> <p>My interest in an engineering major outweighs any disadvantages I can think of.</p> <p>I want to be an engineer.</p>
10	Test Anxiety	Test Anxiety	<p>When I take a test I think about how poorly I am doing compared to other students.</p> <p>When I take a test I think about items on other parts of the test I can't answer.</p> <p>When I take tests I think of the consequences of failing.</p> <p>I feel my heart beating fast when I take an exam.</p> <p>I have an uneasy, upset feeling when I take an exam.</p>
11	Time and Study Environment	Time and Study Environment	<p>I make good use of my study time for my courses.</p> <p>I make sure I keep up with the weekly readings and assignments for my courses.</p> <p>*I find it hard to stick to a study schedule.</p> <p>*I often find that I don't spend very much time on my courses because of other activities.</p>
12	Perceptions of faculty caring	Social Support	<p>I feel comfortable asking a faculty member for help if I do not understand course-related material.</p>

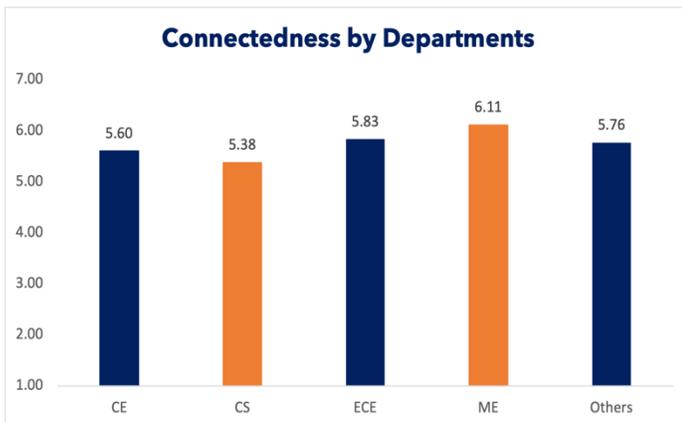
			I feel comfortable seeking help from a faculty member before or after class.
		Empathetic Faculty Understanding	I feel that a faculty member would take the time to talk to me if I needed help.
			I feel that a faculty member would be sympathetic if I was upset.
			I feel that a faculty member really tried to understand my problem when I talked about it.
13	Self-control	Impulsivity	I do certain things that are bad for me, if they are fun.
			Pleasure and fun sometimes keep me from getting work done.
			Sometimes I can't stop myself from doing something, even if I know it is wrong.
			I often act without thinking through all the alternatives.
14	Stress	Frustrations	I have experienced frustrations due to delays in reaching my goals.
			I have experienced daily hassles which affected me in reaching my goals.
			I have experienced failures in accomplishing the goals that I set.
		Conflicts	Produced by two or more positive options.
			Produced by two or more negative options.
			Produced when a goal had both positive and negative options.
		Changes	Rapid unpleasant changes.
			Too many changes occurring at the same time.
			Change which disrupted my life and/or goals.
		Reactions	Experienced physical reactions (sweating, biting fingernails, headaches, etc.)
			Experienced fear, anxiety, worry, frustration, etc.
			Cried, was irritable towards others, separated myself from others, indulged excessively, etc.
		Support	Sought family support (talked to parents, siblings, etc.)
			Sought peer support (talked to friends, classmates, etc.)

Executive Summary

2018

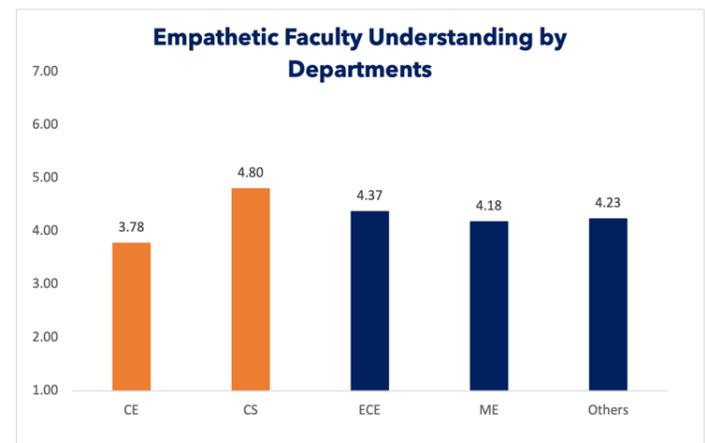
BY DEPARTMENTS

This section summarizes the results of the SUCCESS surveys from 2018 through 2022, focusing on the differences within the year across departments. The UTEP research teams collected participants' department information from the CIERP (the Center for Institutional Evaluation, Research, and Planning) at UTEP. For data analysis purposes, the team only included four departments that made up at least 10 % of the total participants for each year: Civil Engineering (CE), Computer Science (CS), Electrical and Computer Engineering (ECE), Mechanical Engineering (ME), and others. Others include those who completed the survey but were not enrolled in the four departments. One-way analysis-of-variance (ANOVA) models were used to determine if there was a statistically significant difference between the means of each department and used Tukey-Kramer pairwise post hoc testing to determine whether there is a difference between the mean of all possible pairs using a studentized (Lee & Lee, 2018). The result is statistically significant at the 0.05 level ($p < .05$). In the graphs, if there was a statistically significant difference across departments, we highlighted the bar in orange. In the Fall 2020 and Spring 2022 UTEP SUCCESS survey results, the team did not find any statistically significant differences across departments; thus, the results are not included in this report. Also, in the result of Spring 2021, the ME department is not included due to a smaller sample size than in previous years.



In 2018, students who completed the SUCCESS survey and enrolled in the Department of Mechanical Engineering reported higher levels of connectedness than those in the Department of Computer Science.

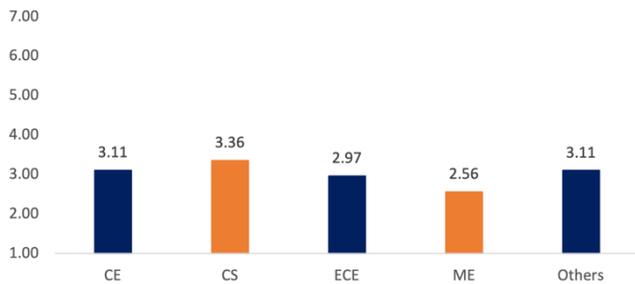
The students who completed the SUCCESS survey in Spring 2018 and enrolled in the Department of Computer Science reported significantly higher levels of empathetic faculty understanding than those in the Department of Civil Engineering.



2019

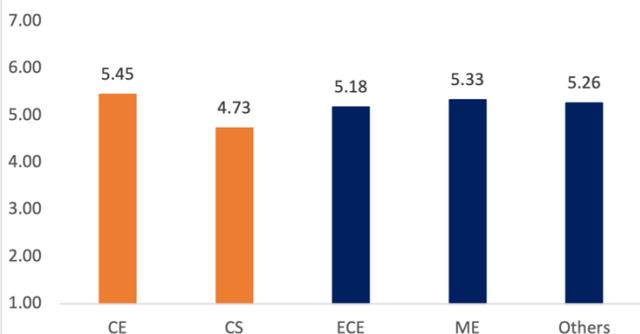
BY DEPARTMENTS

Neuroticism by Departments



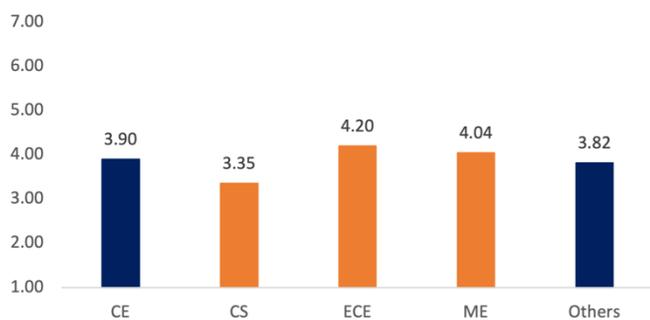
In 2019, the students who completed the SUCCESS survey and enrolled in the Department of Computer Science report significantly higher levels of neuroticism compared to the students enrolled in the Department of Mechanical Engineering.

Conscientiousness by Departments



The students who completed the SUCCESS survey and enrolled in the Department of Computer Science report significantly lower levels of conscientiousness than those enrolled in the Department of Civil Engineering in 2019.

Grit by Departments



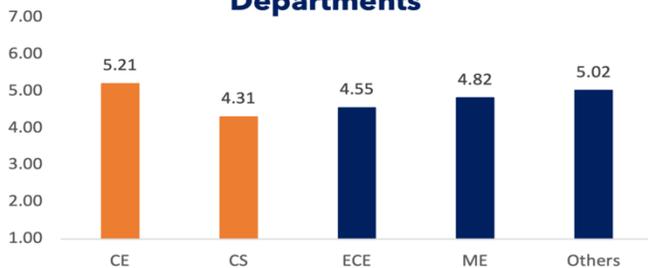
In 2019, the students enrolled in the Department of Computer Science report significantly lower levels of grit compared to those enrolled in the Department of Electrical and Computer Engineering in 2019.

A statistically significant difference is also observed between the mean scores of the students in CS and the students in ME. Students in CS department reported lower levels of grit than those in the ME department in 2019.

2019 (cont.)

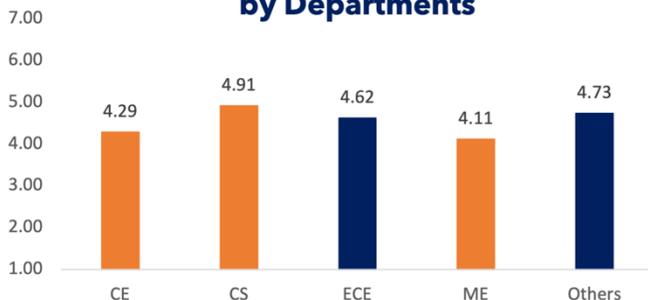
BY DEPARTMENTS

Meaning and Purpose by Departments



- Students enrolled in the CE department report significantly higher levels of meaning and purpose compared to students enrolled in the CS department in 2019.

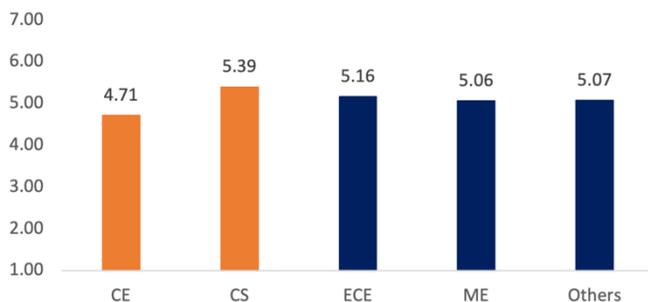
Empathetic Faculty Understanding by Departments



- Students in the CS department report significantly higher levels of empathetic faculty understanding than those in the CE department. This statistically significant difference is also founded in the result of Spring 2018 survey.

- The higher levels of empathetic faculty understanding from the CS student report are also observed compared to those in the ME department.

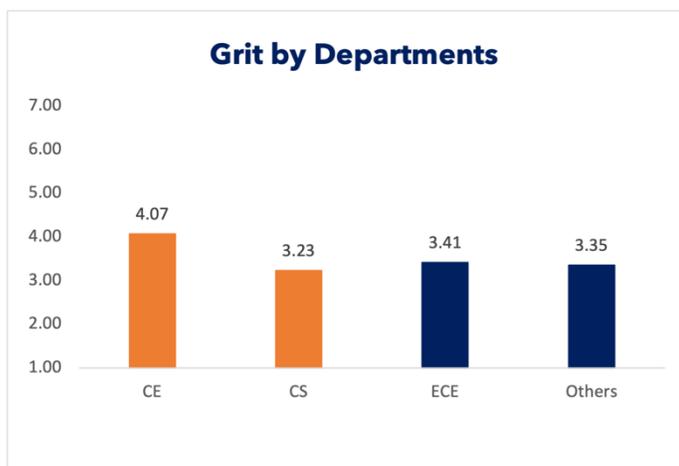
Frustrations by Departments



- In 2019, students in the CS department report significantly higher levels of frustrations compared to those enrolled in the CE department.

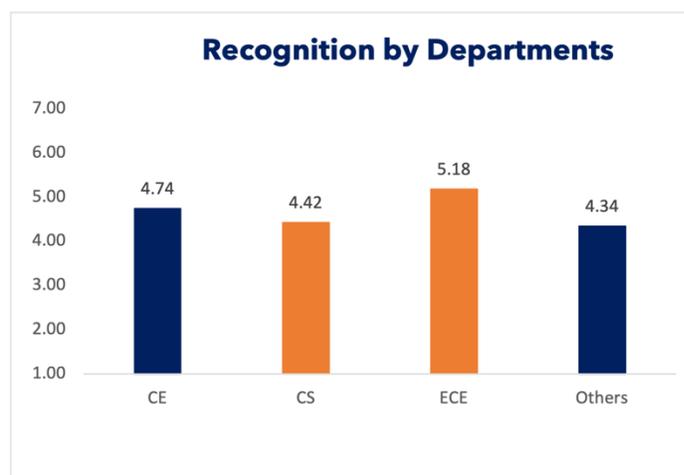
2021

BY DEPARTMENTS



The students who completed the SUCCESS survey in Spring 2021 and enrolled in the CS department report significantly lower levels of grit than those in the CE department. The lower levels of grit from the CS student report are also observed in the results of the 2019 SUCCESS survey, compared to the ECE students.

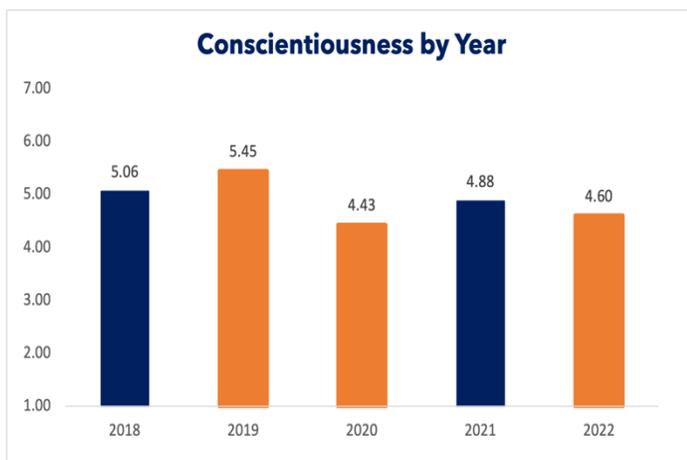
In 2022, the ECE students report significantly higher levels of recognition compared to the students in the CS department.



Civil Engineering

BY YEAR

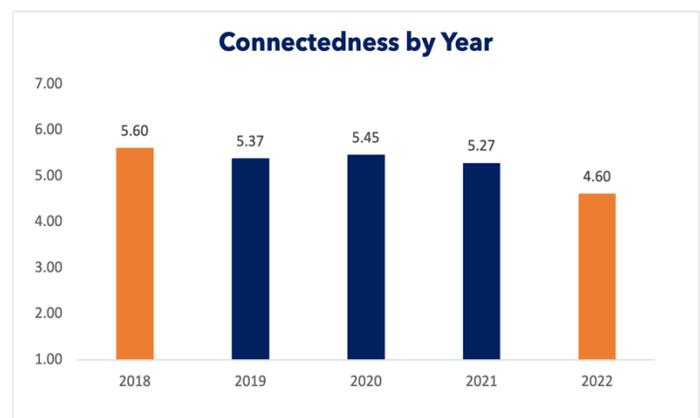
This section summarizes the results of the SUCCESS surveys from 2018 through 2022, focusing on the differences within the department by year. The UTEP research teams collected participants' department information from the CIERP (the Center for Institutional Evaluation, Research, and Planning) at UTEP. For data analysis purposes, the team only included four departments that made up at least 10 % of the total participants for each year: Civil Engineering (CE), Computer Science (CS), Electrical and Computer Engineering (ECE), and Mechanical Engineering (ME). One-way analysis-of-variance (ANOVA) models were used to determine if there was a statistically significant difference between the means of each year and used Tukey-Kramer pairwise post hoc testing to determine whether there is a difference between the mean of all possible pairs using a studentized (Lee & Lee, 2018). The result is statistically significant at the 0.05 level ($p < .05$). In the graphs, if there was a statistically significant difference across departments, we highlighted the bar in orange.



In the comparison between departments in the 2019 survey, higher levels of conscientiousness from the CE student report are observed compared to the CS students. Comparing the mean scores by year, students enrolled in the CE department in 2019 report significantly higher conscientiousness levels than in 2020. This pattern also applies to the comparison between 2019 and 2022.



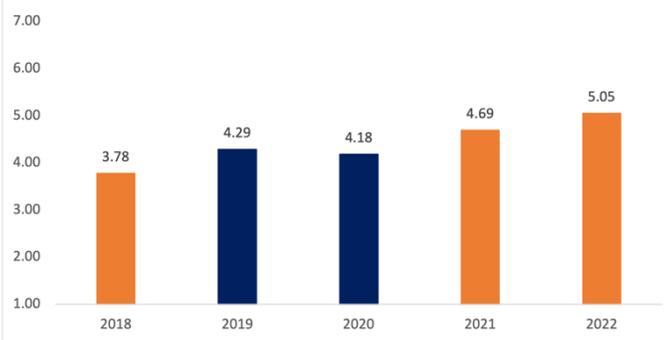
In the CE department, students who participated in the survey in Spring 2018 report significantly higher levels of connectedness than those in Spring 2022.



Civil Engineering (cont.)

BY YEAR

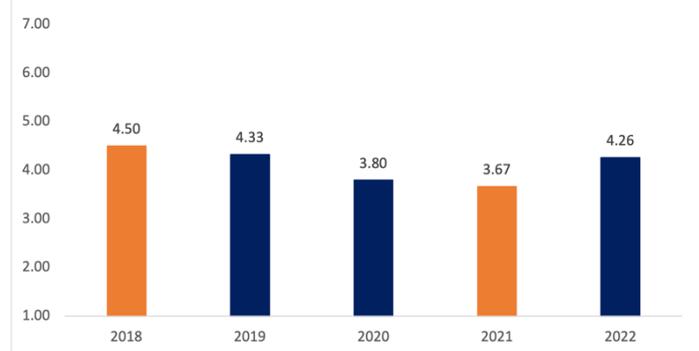
Empathetic Faculty Understanding by Year



● In the comparison across departments, the students enrolled in the CE department report lower levels of empathetic faculty understanding than those in the CS department in the 2018 and 2019 surveys. However, the mean scores increased compared to previous years. Students enrolled in the CE department in 2021 report significantly higher levels of empathetic faculty understanding than those in the department in 2018. This significant difference is also observed between the students enrolled in 2018 and those in 2022.

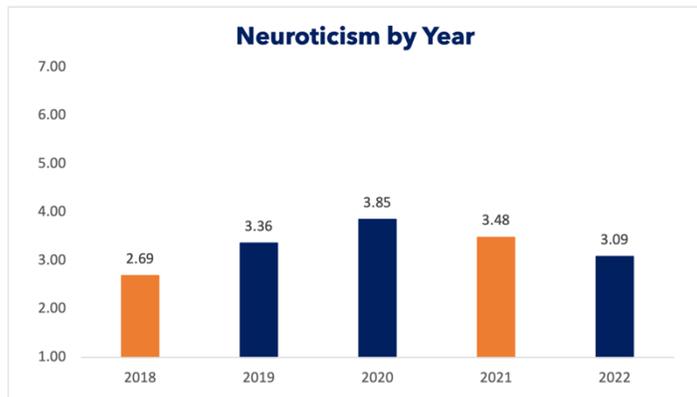
● Students who completed the SUCCESS survey and enrolled in the CE department in 2021 report significantly lower levels of conflicts compared to those in the 2018.

Conflicts by Year



Computer Science

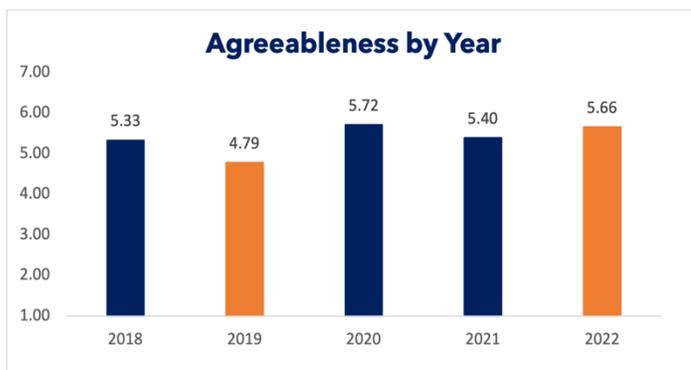
BY YEAR



In the comparison across departments, the students who completed the SUCCESS survey and enrolled in the CS department in 2019 report higher levels of neuroticism than the students in the ME department. Interestingly, the mean scores of the CE student report significantly increased between 2018 and 2021. This means that the CE students who completed the survey and enrolled in the department in 2021 report higher levels of neuroticism than those in 2018.

Electrical & Computer Engineering

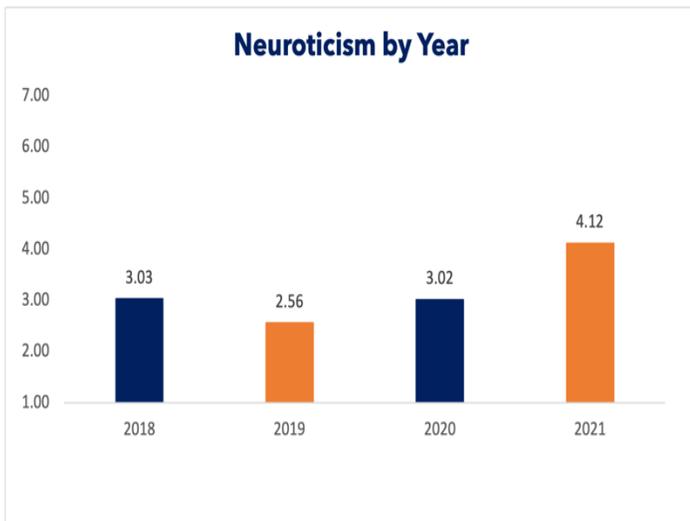
BY YEAR



- Students who participated in the SUCCESS survey and enrolled in the ECE department in 2021 report significantly higher agreeableness levels than those in 2019.

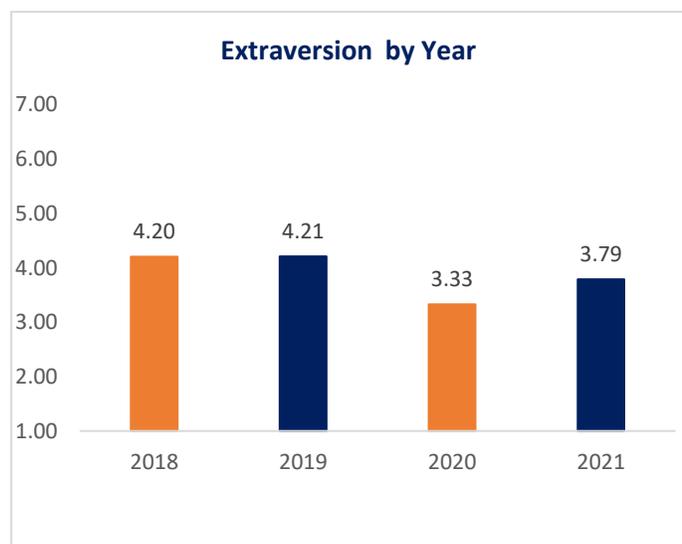
Mechanical Engineering

BY YEAR



● In the comparison across departments, the mean scores of neuroticism from the ME student report in 2019 are lowered than the CS students. However, within the ME department, the students who completed the survey and enrolled in 2021 report significantly higher levels of neuroticism than those in 2019.

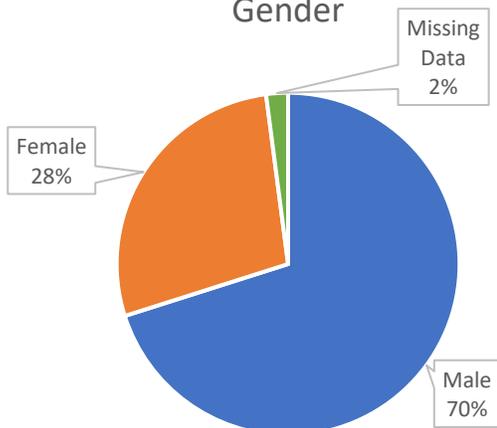
● Extraversion is one of the big five personality measured in the SUCCESS survey. The ME students who completed the survey in 2020 report significantly lower levels of extraversion compared to the students who completed the survey in the 2018.



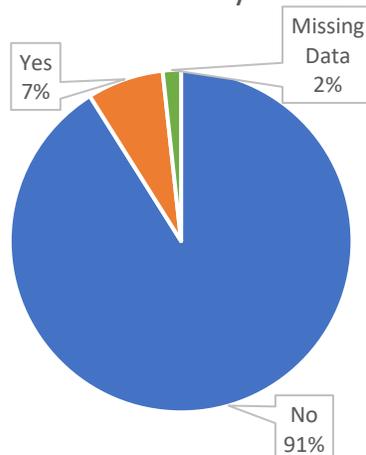
Survey Sample Demographics

Spring of 2018

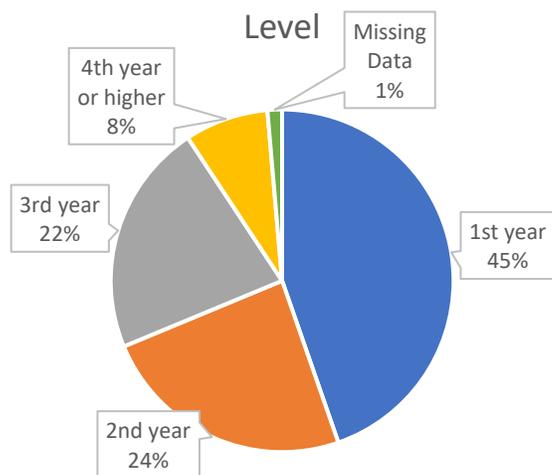
2018 Survey Sample by Gender



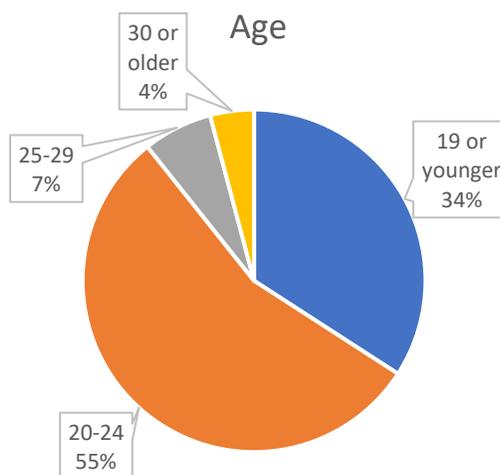
2018 Survey Sample by Sexual minority status



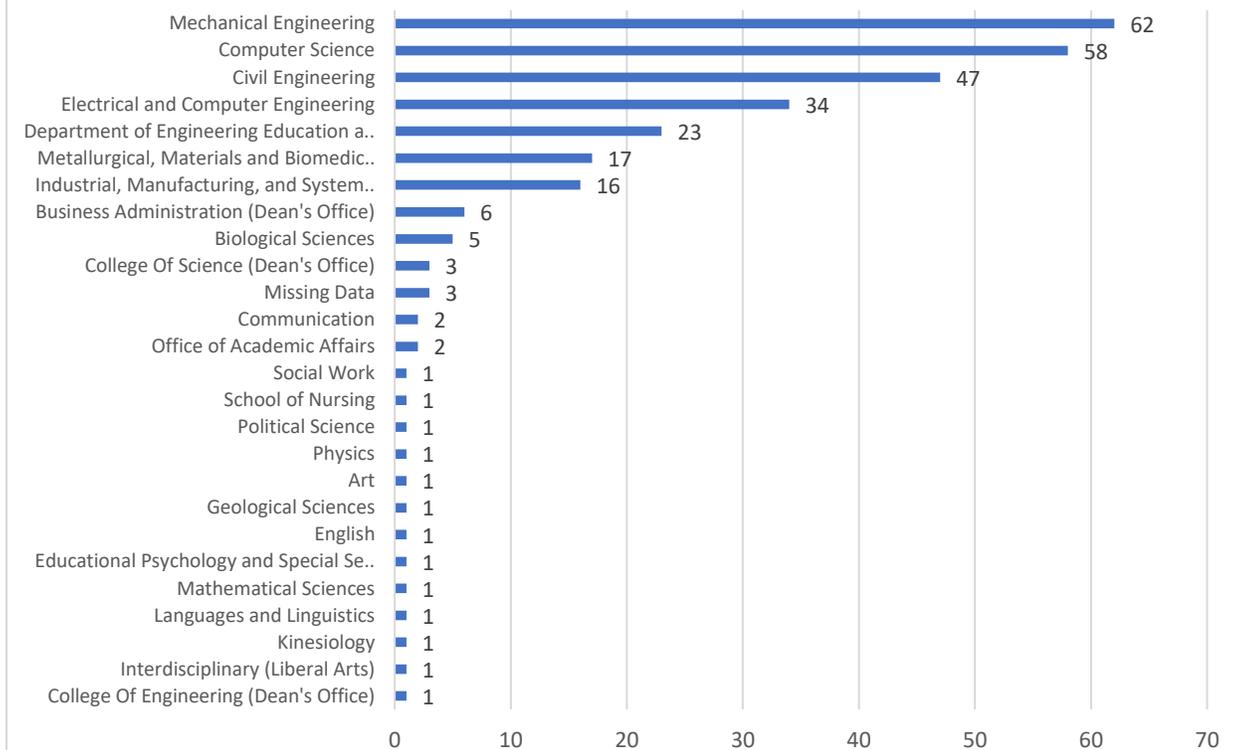
2018 Survey Sample by Class Level



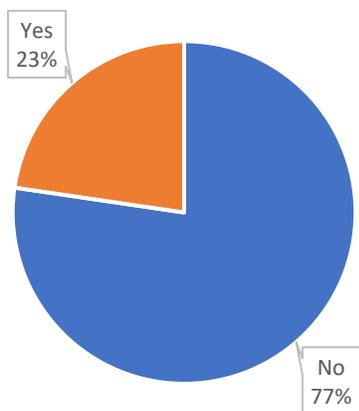
2018 Survey Sample by Age



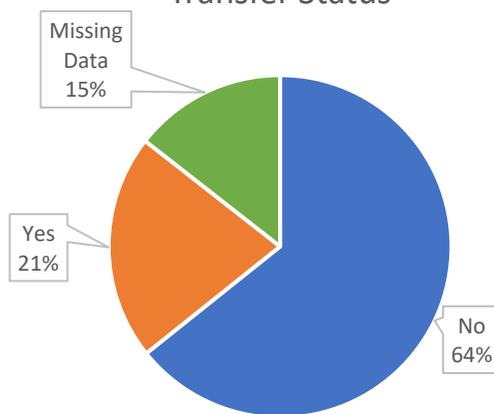
2018 Survey Sample by Department from IR data



2018 Sample Survey by First-generation college status

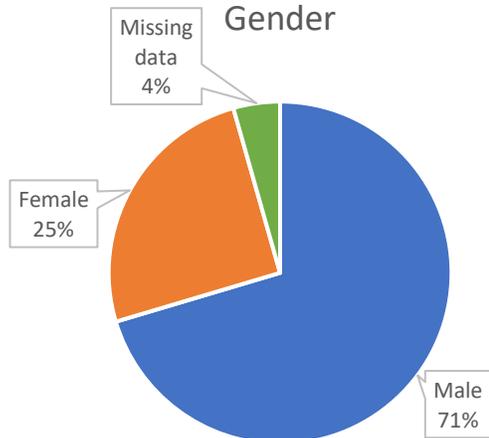


2018 Survey Sample by Transfer Status

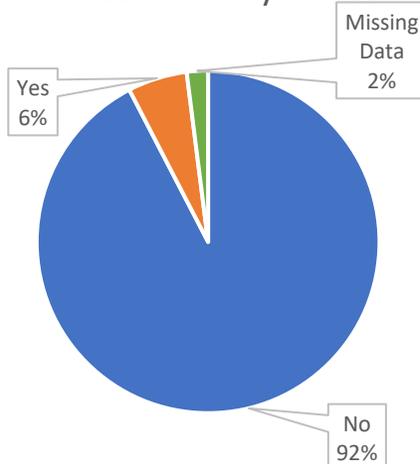


Spring of 2019

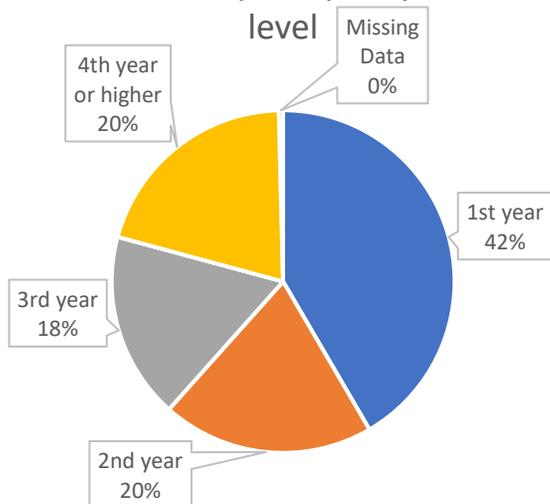
2019 Survey Sample by Gender



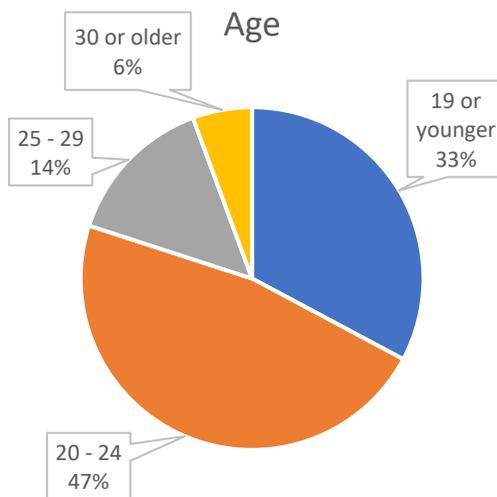
2019 Survey Sample by Sexual minority status



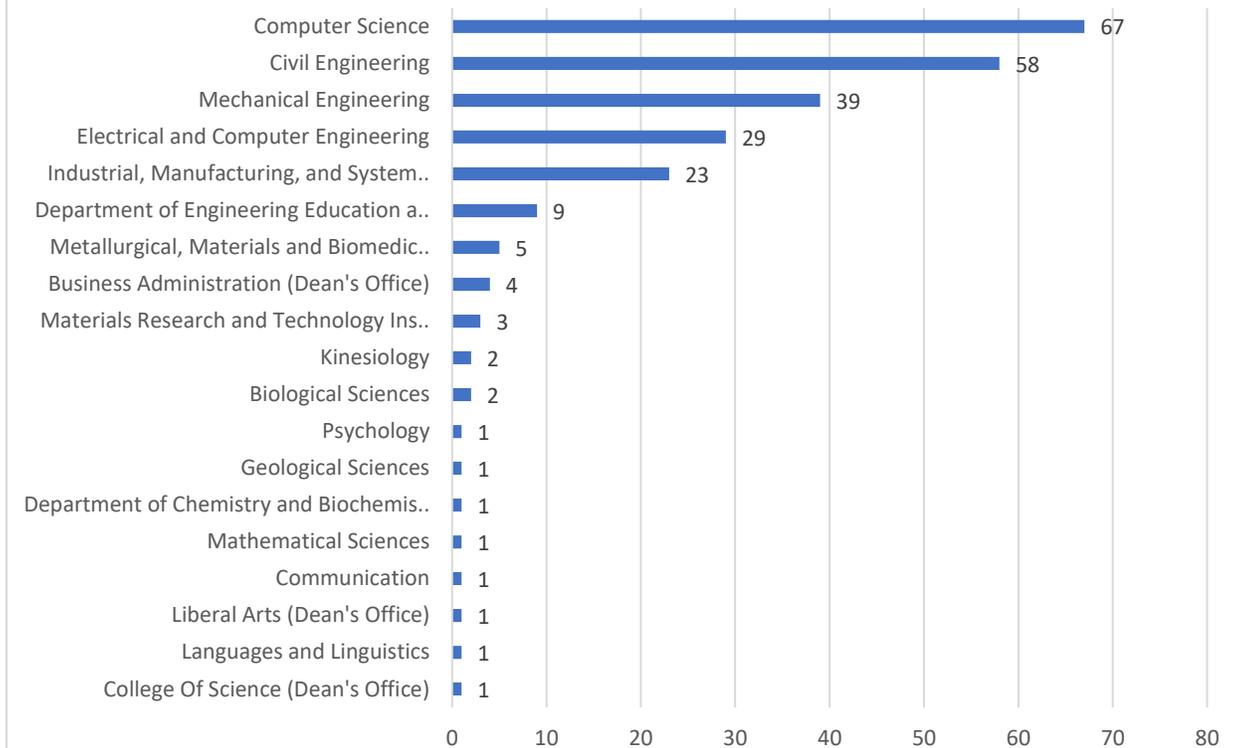
2019 Survey Sample by Class level



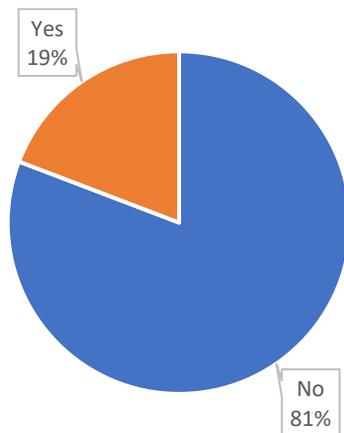
2019 Survey Sample by Age



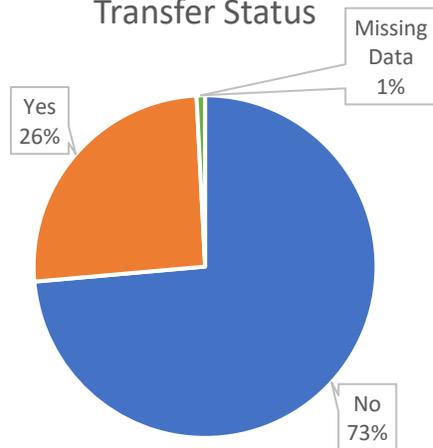
2019 Survey Sample by Department from IR data



2019 Survey Sample by First-generation college status

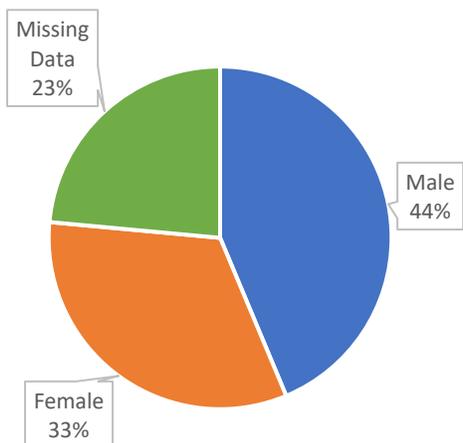


2019 Survey Sample by Transfer Status

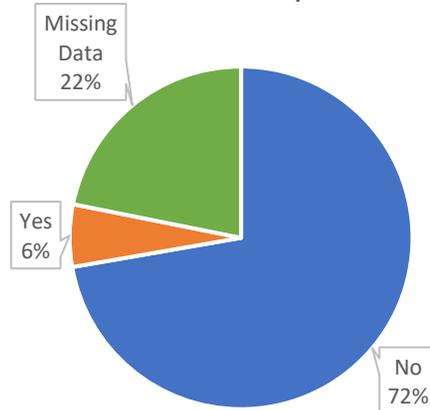


Fall of 2020

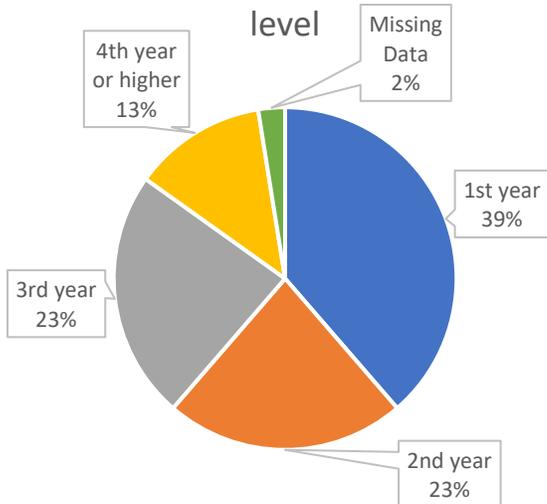
2020 Survey Sample by Gender



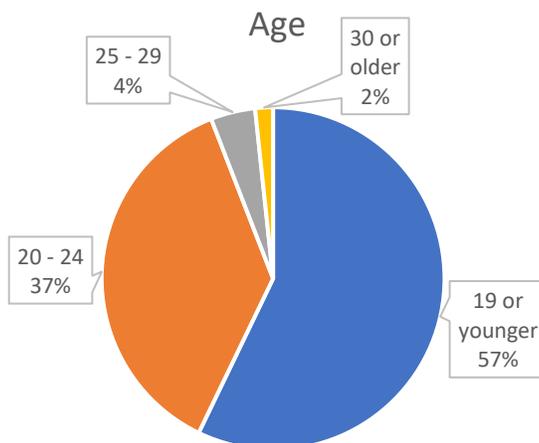
2020 Survey Sample by Sexual Minority Status



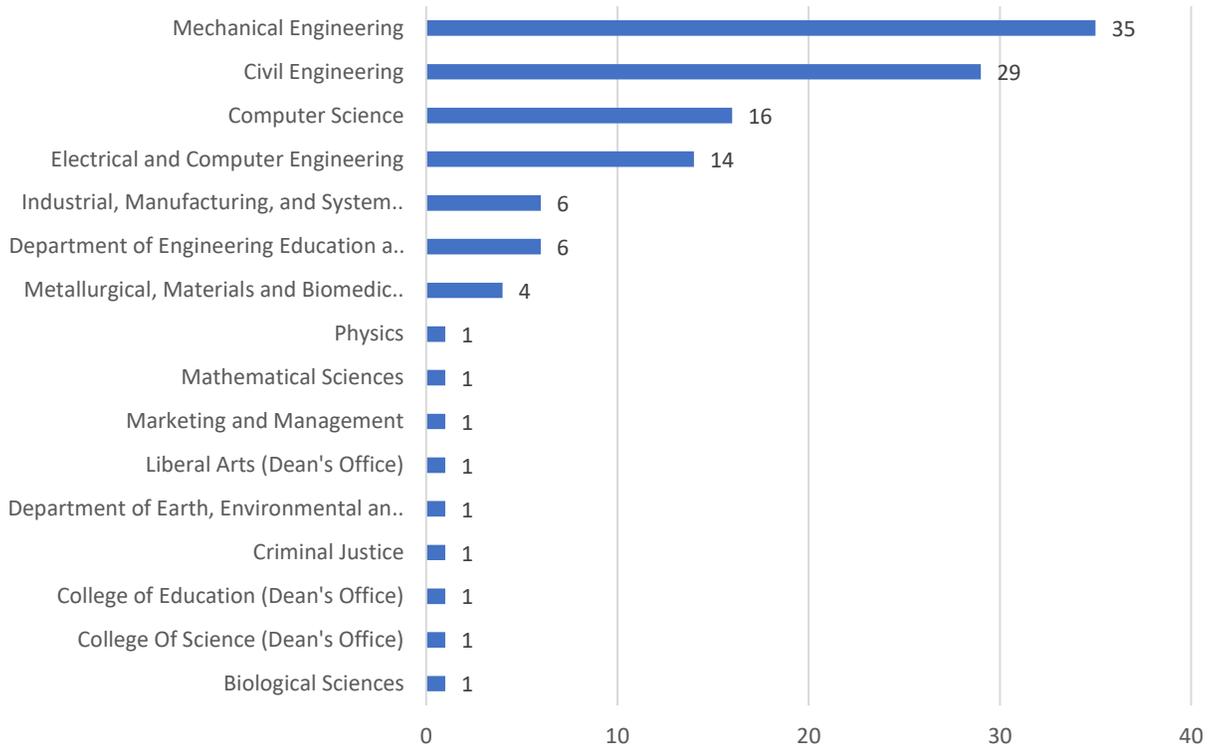
2020 Survey Sample by Class level



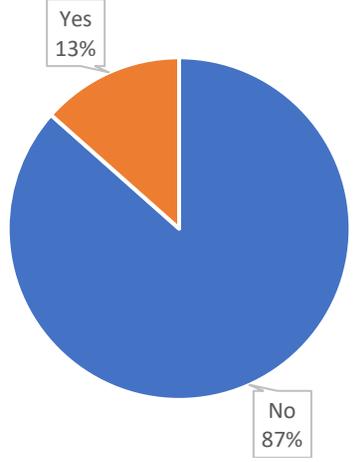
2020 Survey Sample by Age



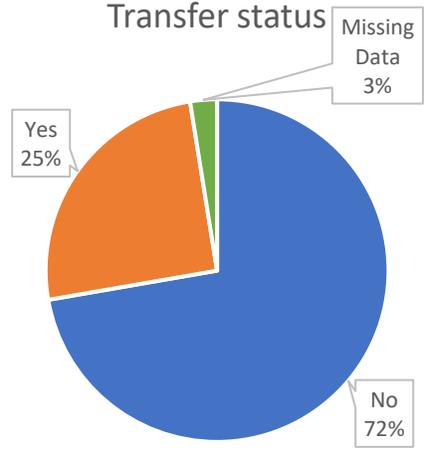
2020 Survey Sample by Department from IR data



2020 Survey Sample by First-generation college status

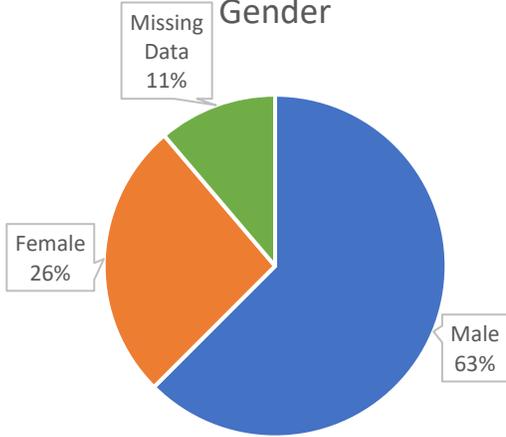


2020 Survey Sample by Transfer status

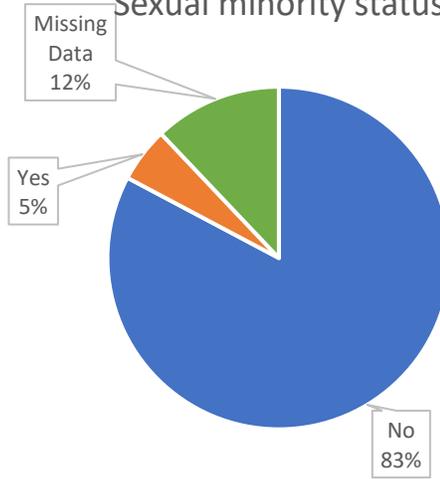


Spring of 2021

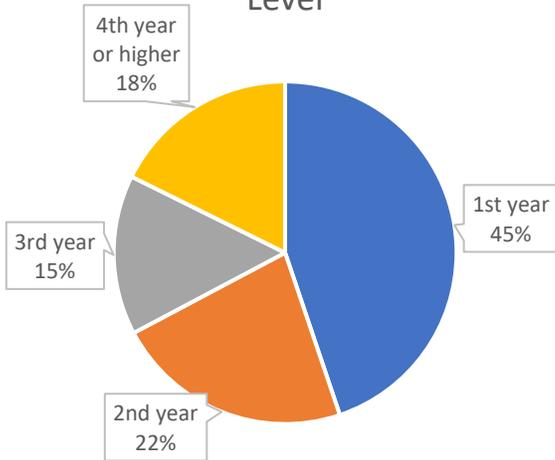
2021 Survey Sample by Gender



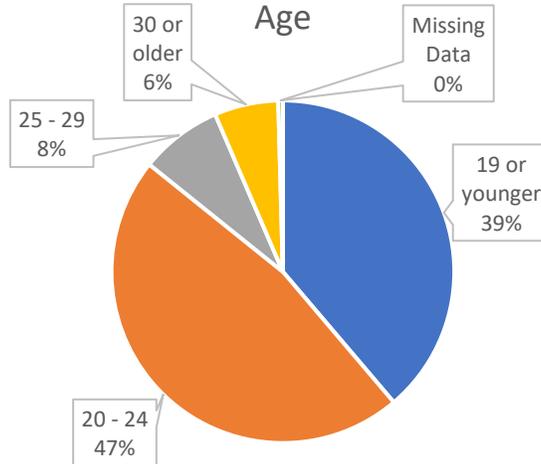
2021 Survey Sample by Sexual minority status



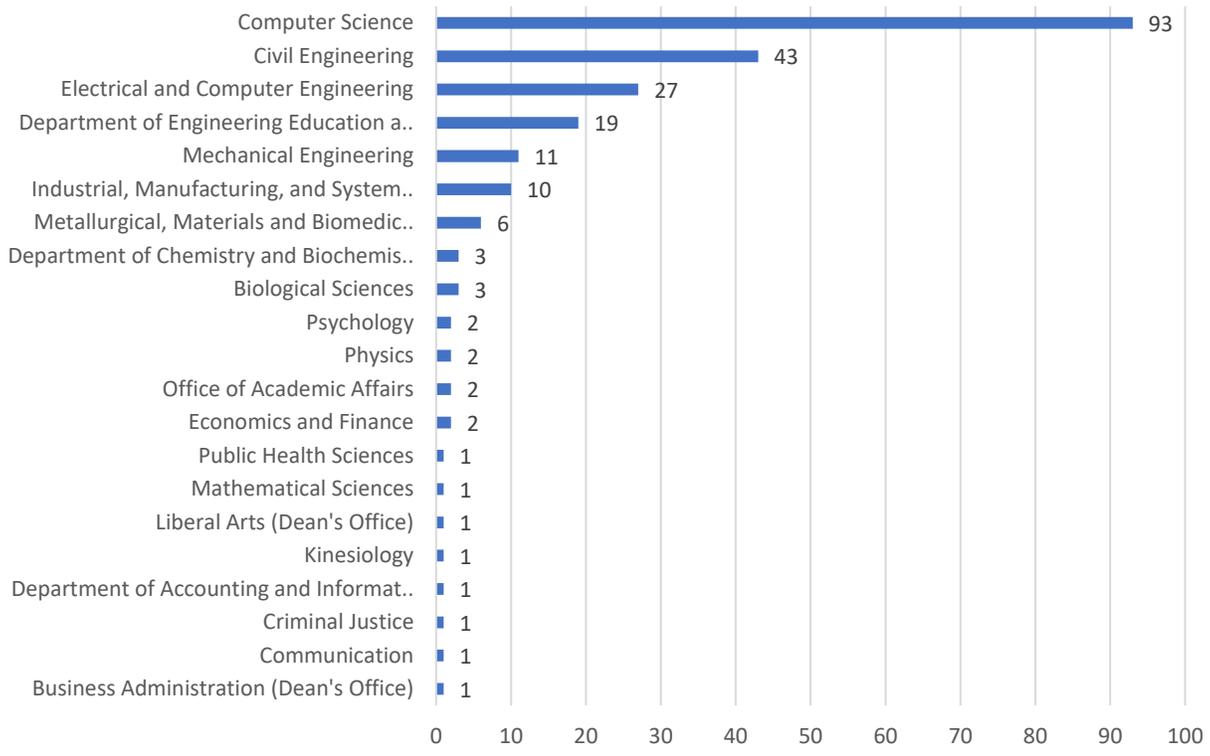
2021 Survey Sample by Class Level



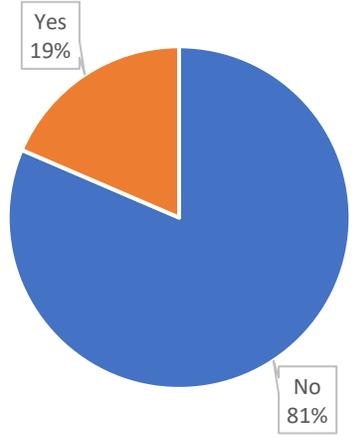
2021 Survey Sample by Age



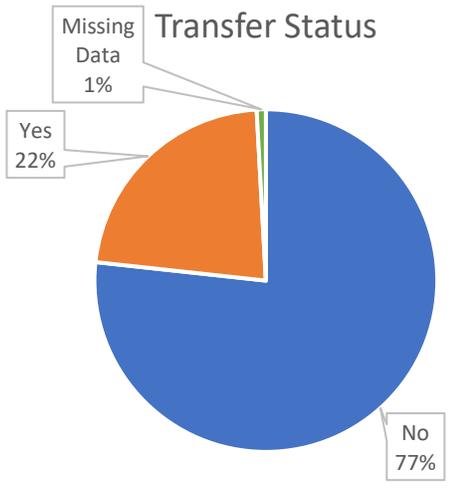
2021 Survey Sample by Department from IR data



2021 Survey Sample by First-generation College Status

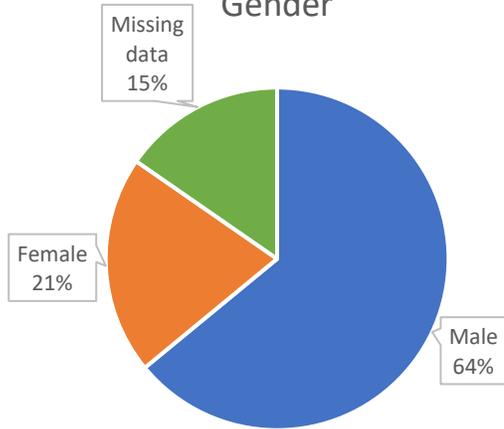


2021 Survey Sample by Transfer Status

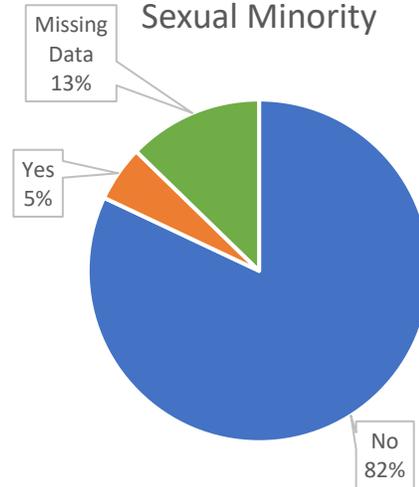


Spring of 2022

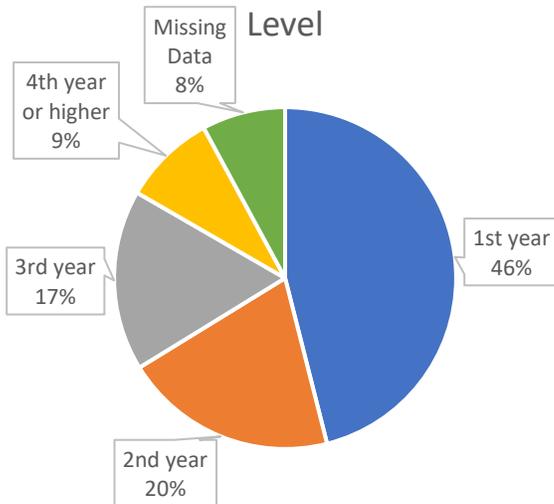
2022 Survey Sample by Gender



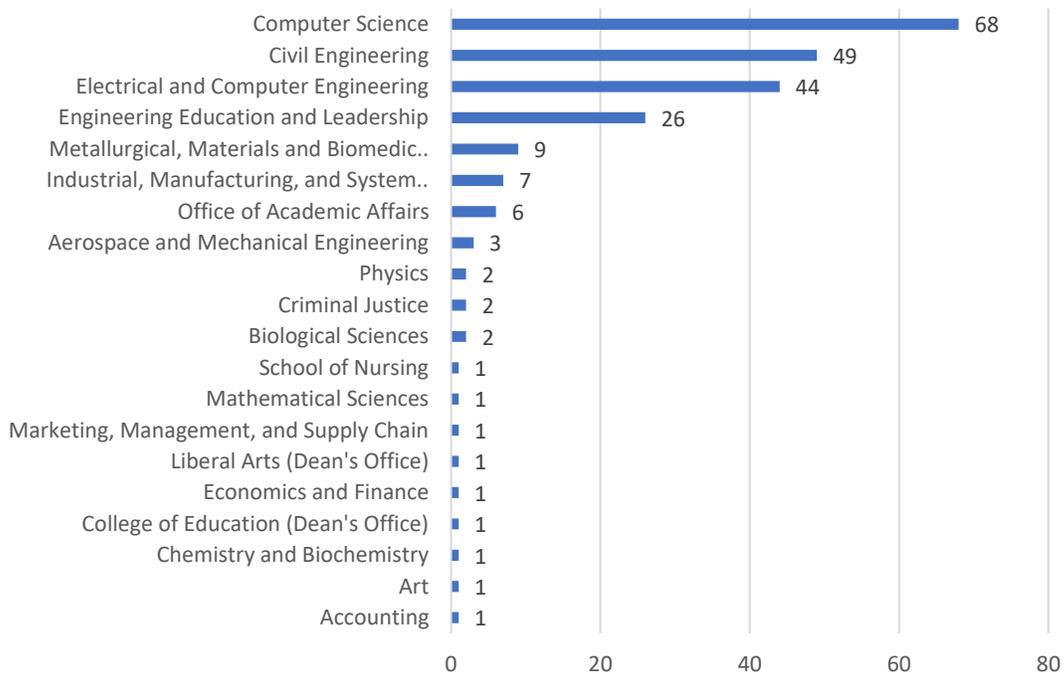
2022 Survey Sample by Sexual Minority



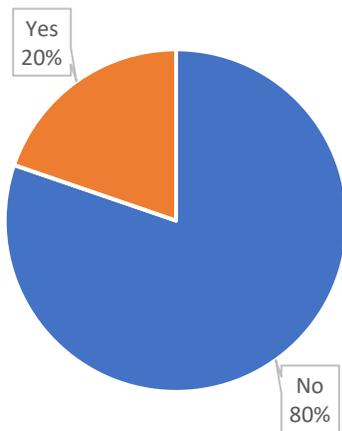
2022 Survey Sample by Class Level



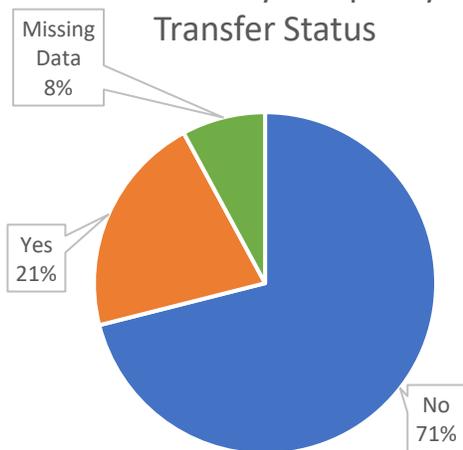
2022 Survey Sample by Department from IR data



2022 Survey Sample by First-generation College Status



2022 Survey Sample by Transfer Status



Student Survey Outcomes

This section includes student survey outcomes of 28 NCA profiles by student demographics (gender, sexual minority status, age), college enrollment status (first-generation college status, transfer status), and employment status during college (i.e., paid work), conducting separate analyses for each year from Spring 2018 to Spring 2022. In the results of Spring 2022, the analysis by age does not be included. The graphs with the title highlighted in red indicate statistically significant group differences (** $p < .05$.) To help better understand each NCA profile, this section also briefly describes the 28 NCA constructs measured on the SUCCESS survey. Each factor is described with references and potential malleability established in the literature. For consistency purposes, we used the same description presented in “SUCCESS: Studying Underlying Characteristics of Computing and Engineering Student Success: SUCCESS Survey Customized Report for California Polytechnic State University,” published in 2018. UTEP research team connected student survey responses to portions of student academic records and the Dean of Student’s record to examine relationships among your survey responses and student academic and non-academic outcomes. c

Big Five Personality

1) Neuroticism

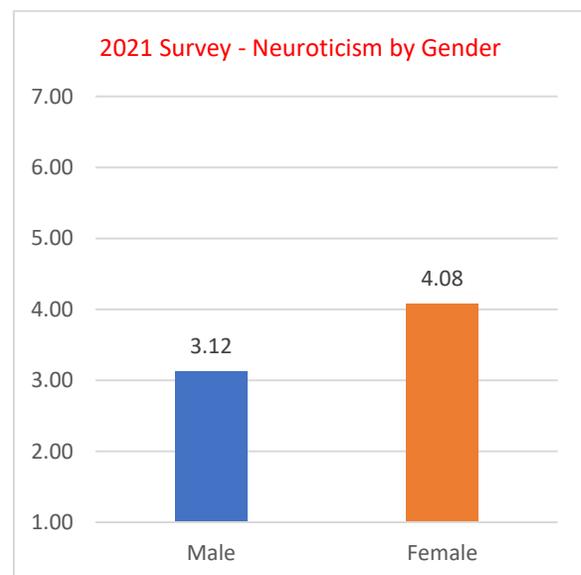
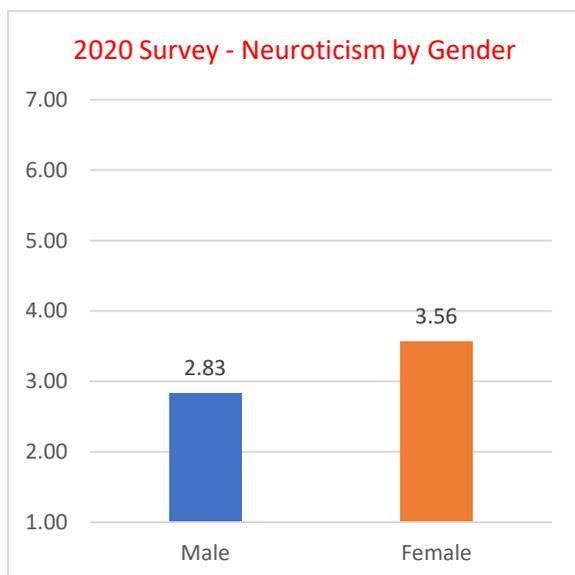
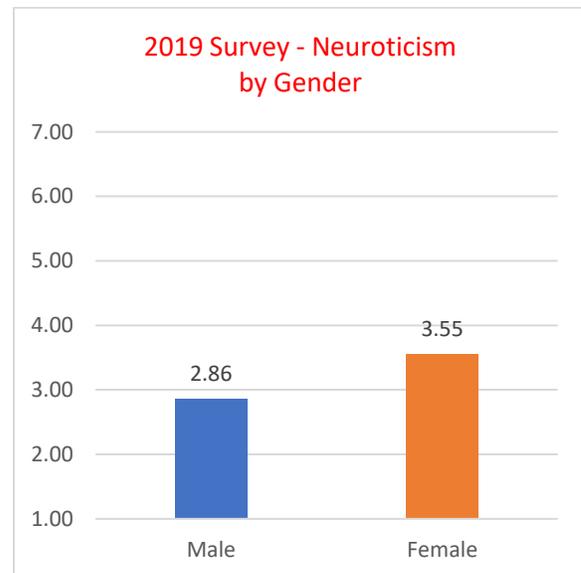
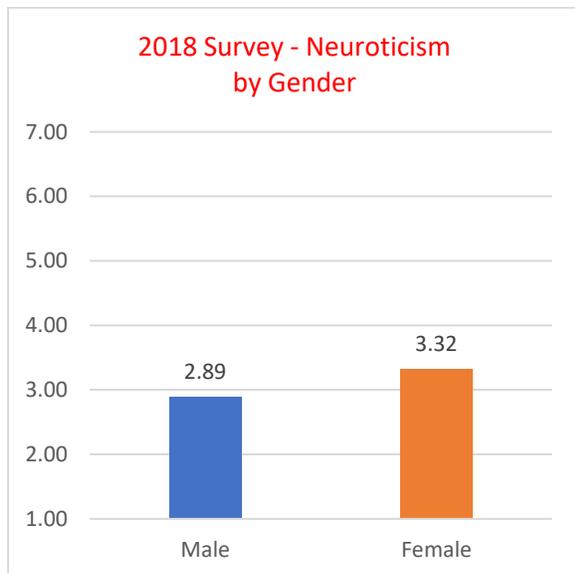
The Big-Five personality traits, sometimes referred to as the five-factor model [62], characterize personality across five dimensions: openness (open to change and new experiences, imaginative, insightful); conscientiousness (reliable, hardworking, trustworthy, dependable, orderly, thorough); extraversion (sociable, talkative, impulsive, energetic, assertive); agreeableness (cooperative, helpful, likeable, sympathetic, kind); and neuroticism (anxiety, personal insecurity, tension, hostility, irritability). A large number of big five survey instruments exist (including both very long and very short [40]), and we used a 15-item version comprising three items per big five dimension. Each item presented a statement (e.g., “I have a vivid imagination”), to which respondents rated how accurately that statement described them. Big five dimensions are known to correlate with a variety of desirable academic outcomes [94, 56]. Even highly condensed versions of big five instruments have generally shown acceptable validity and reliability (e.g., [41]).

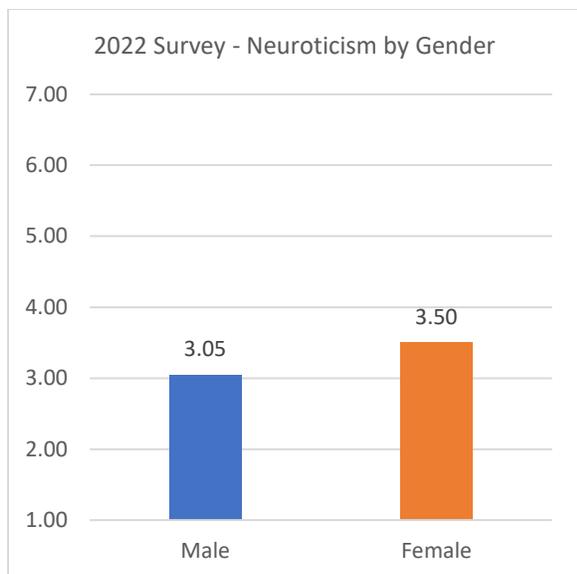
Number of items: 15

Interpretation of the scale: Higher scores on each personality dimension indicate that students are stronger in that dimension

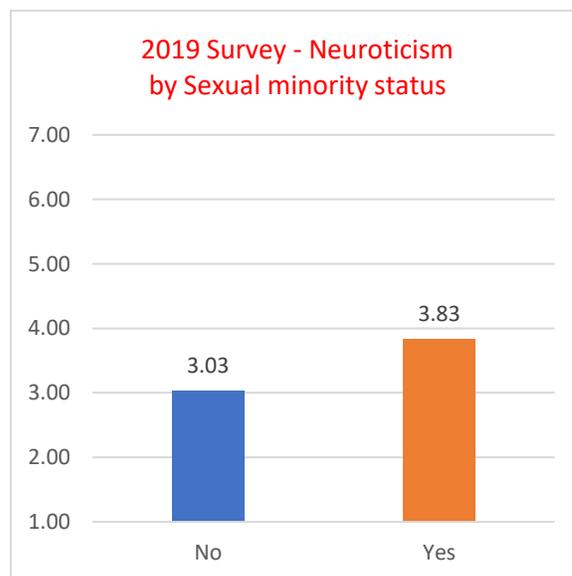
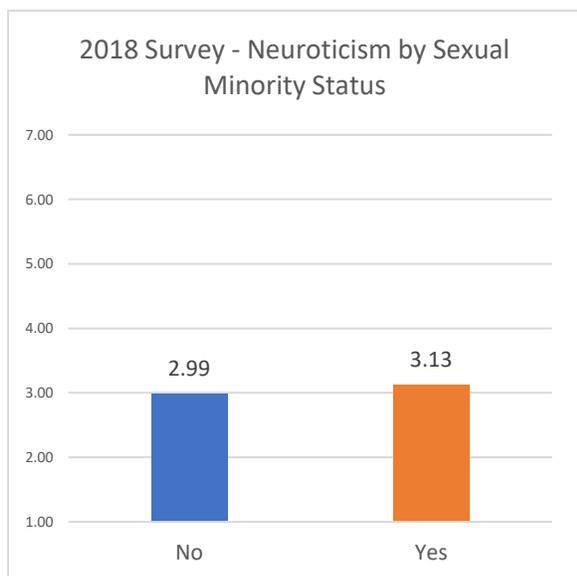
Malleability: These personality traits may change throughout life over a long time-scale and in response to life events [89], although expression of personality traits may depend upon social context [83].

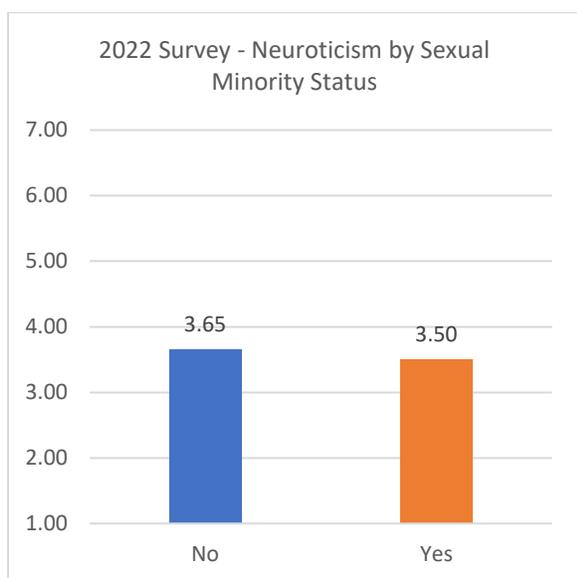
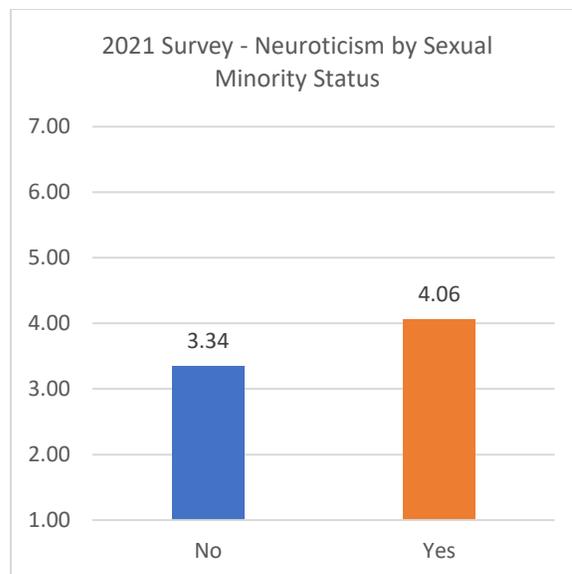
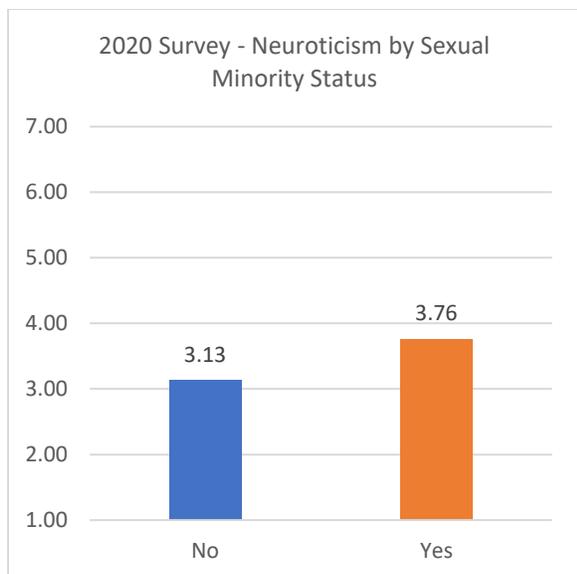
Gender



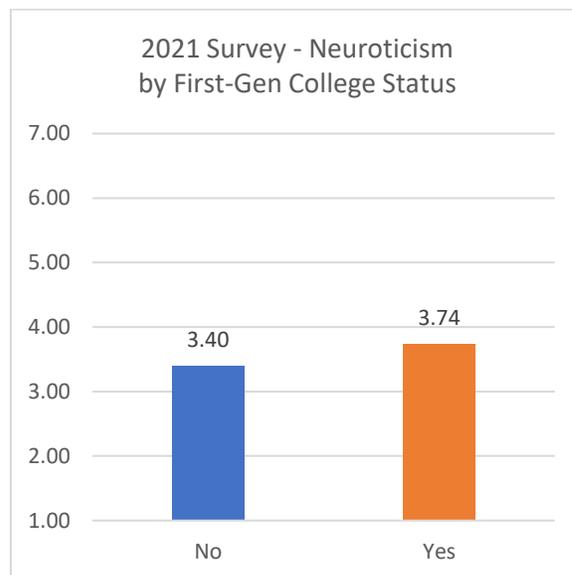
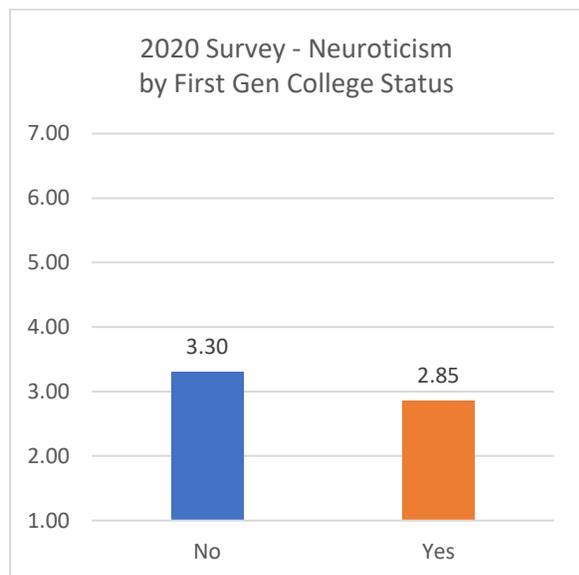
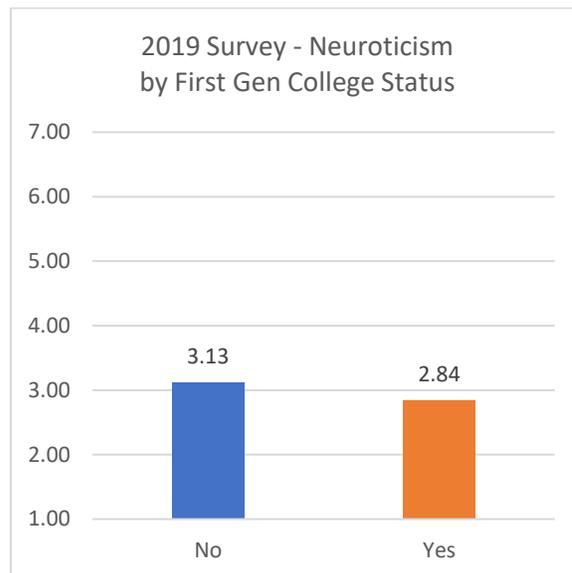
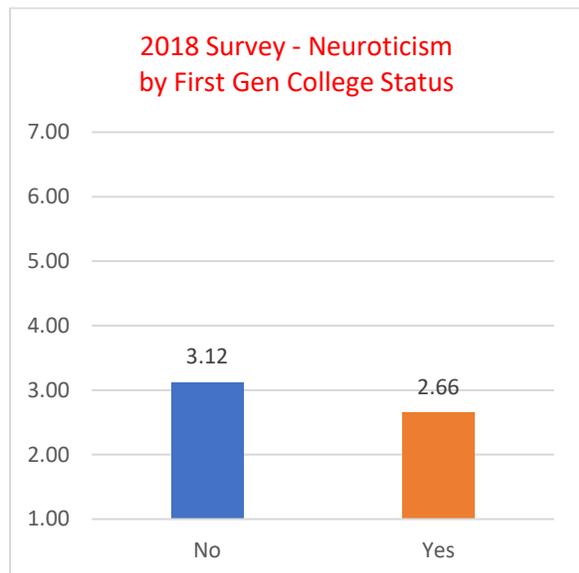


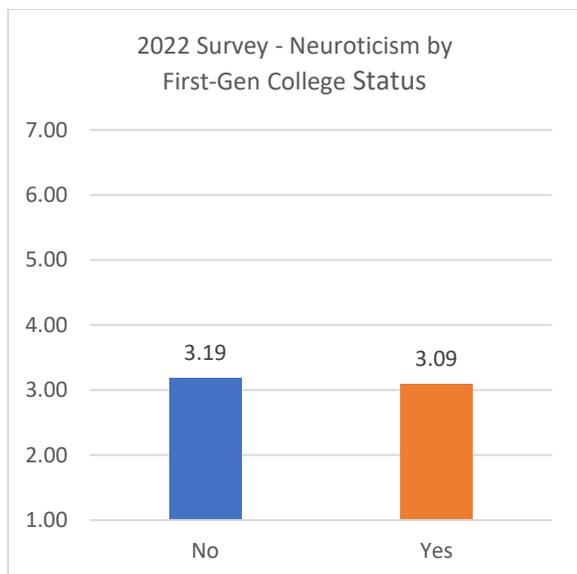
Sexual Minority Status



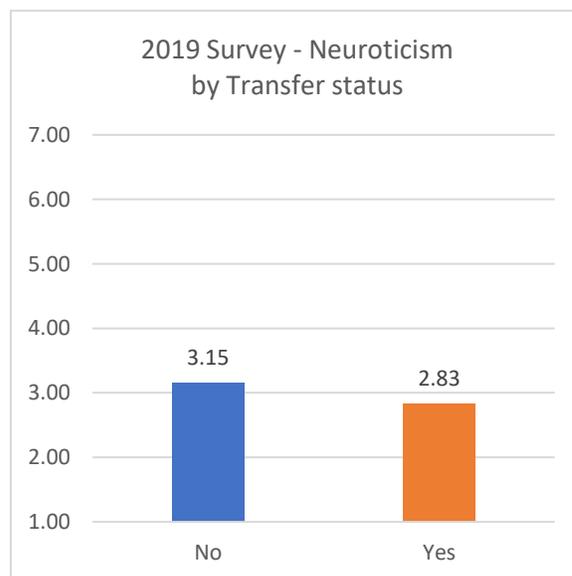
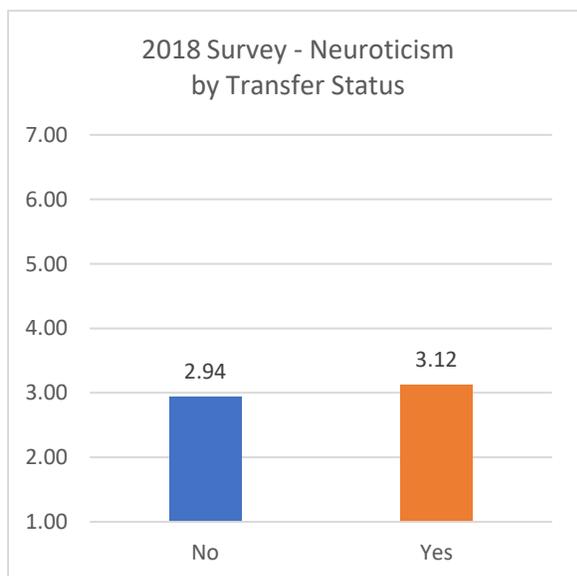


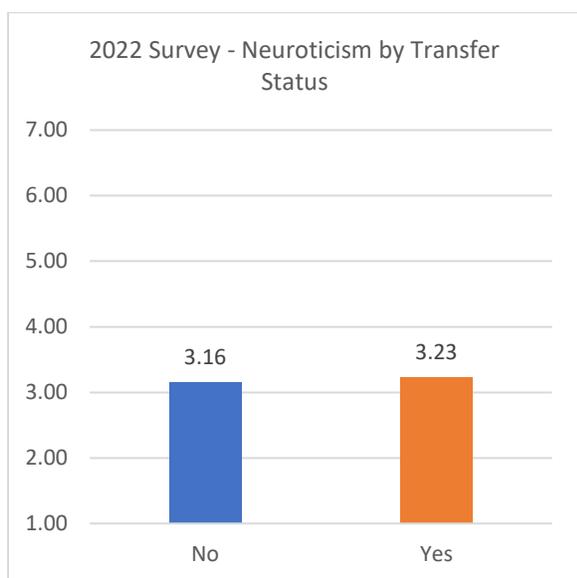
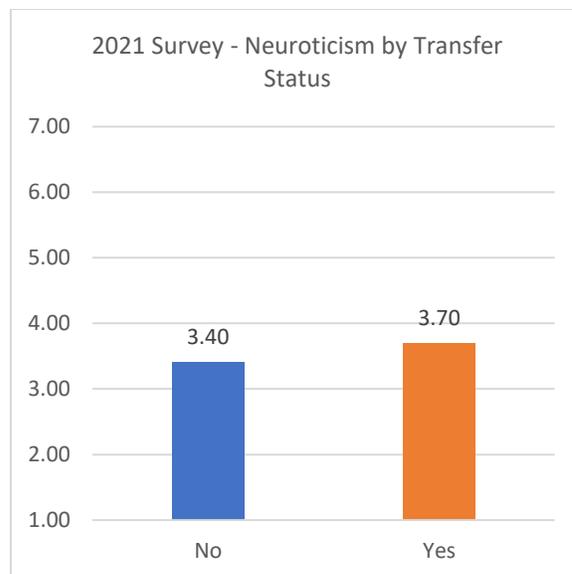
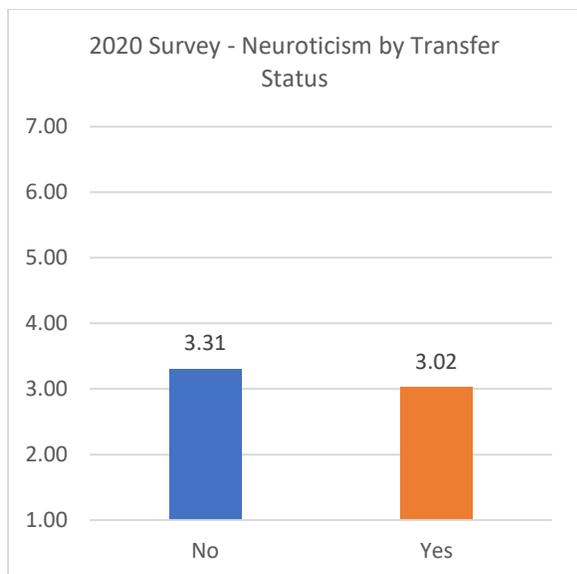
First-generation College Status



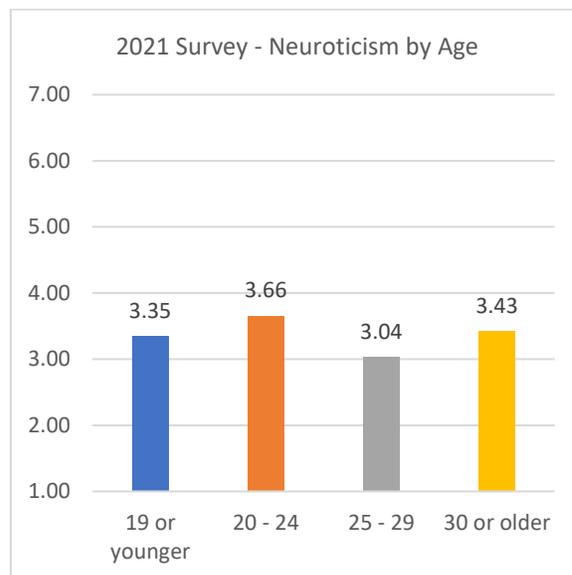
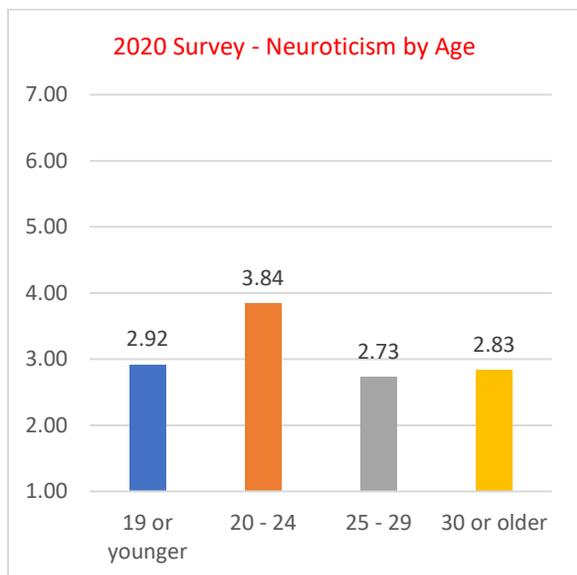
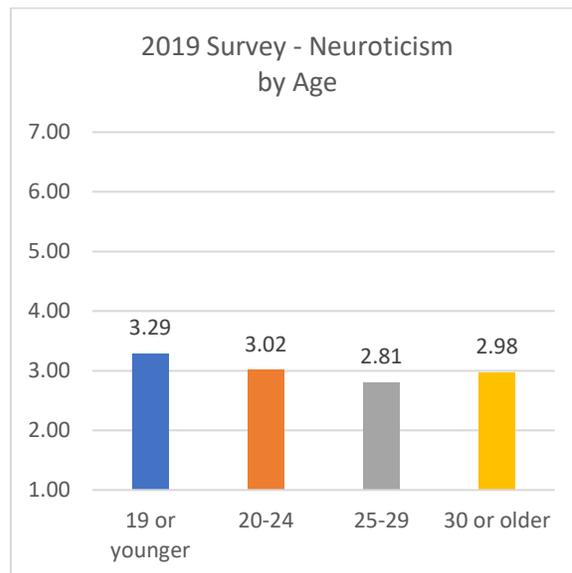
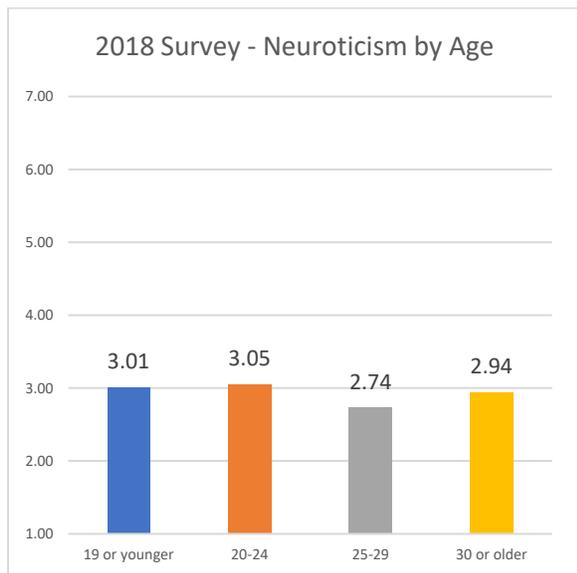


Transfer Status

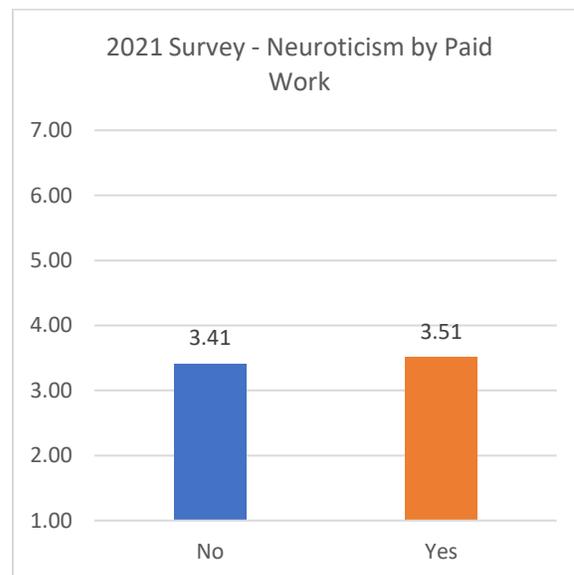
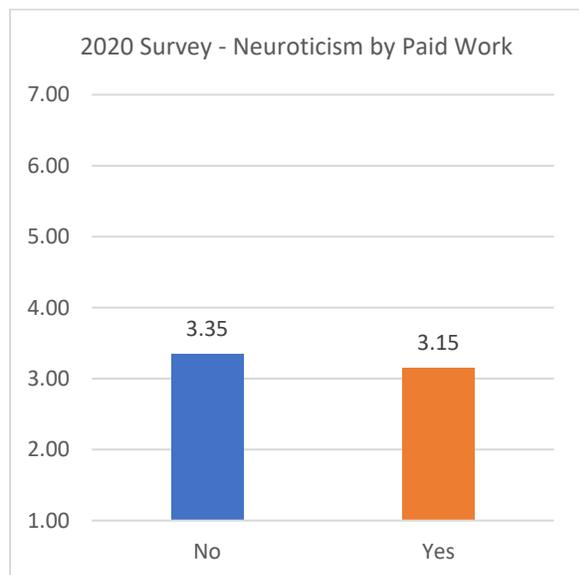
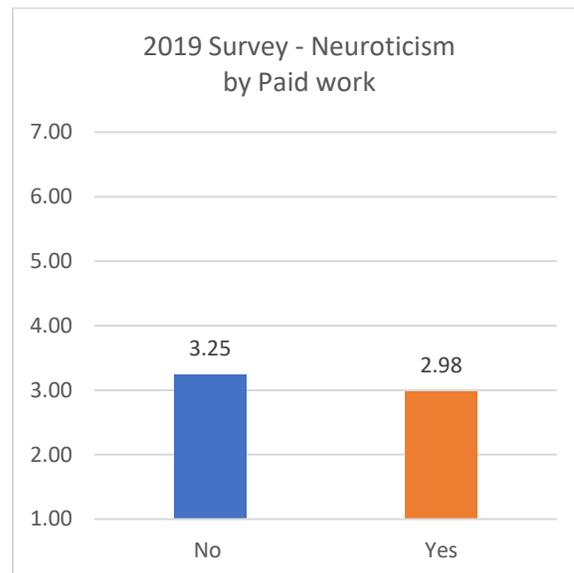
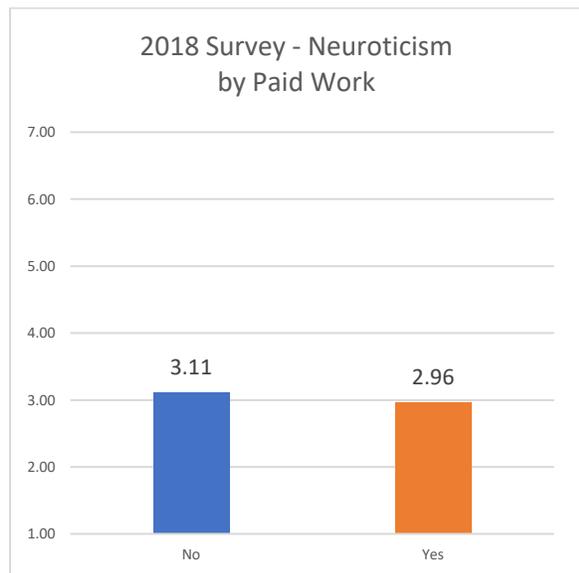


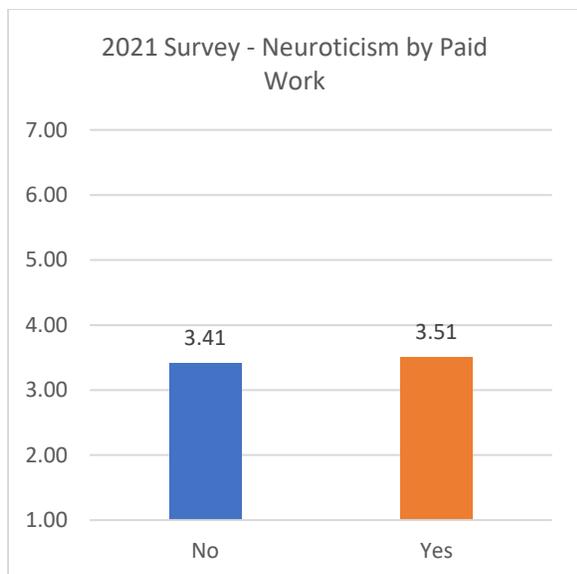


Age



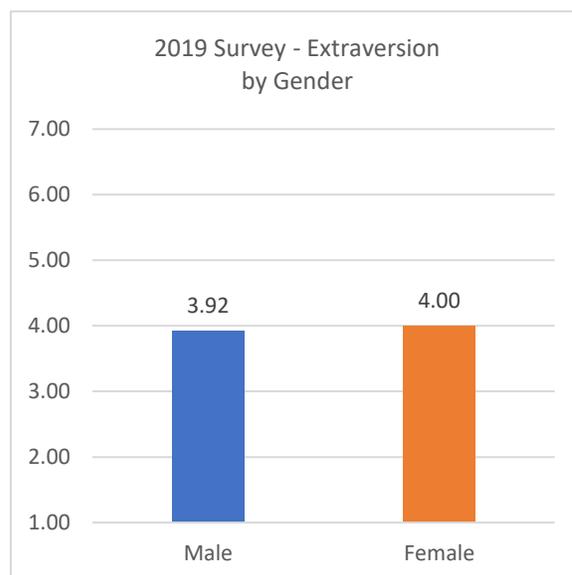
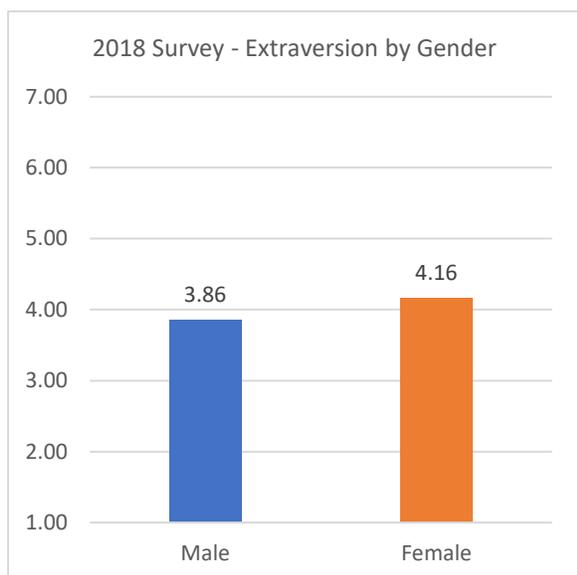
Employment status

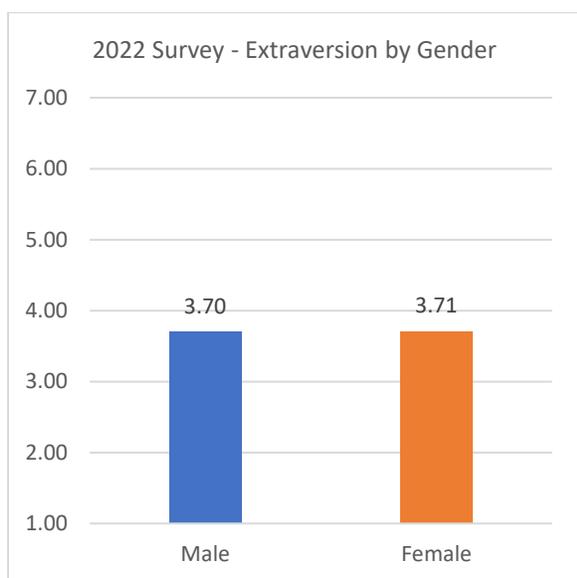
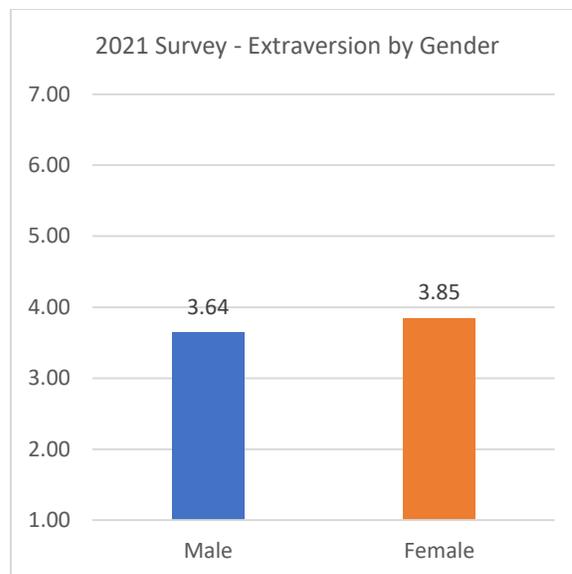
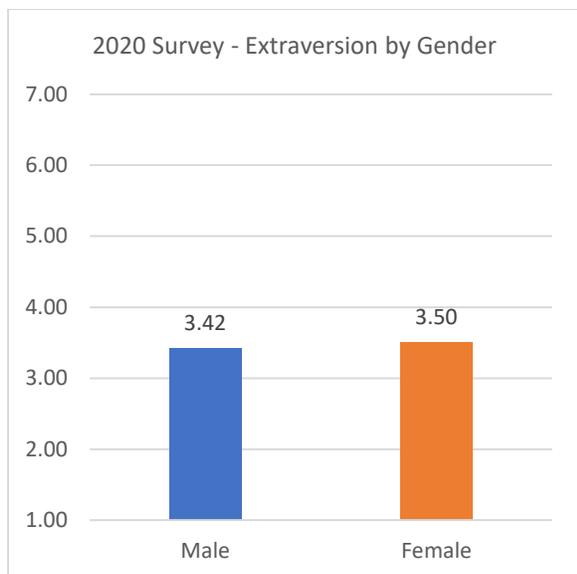




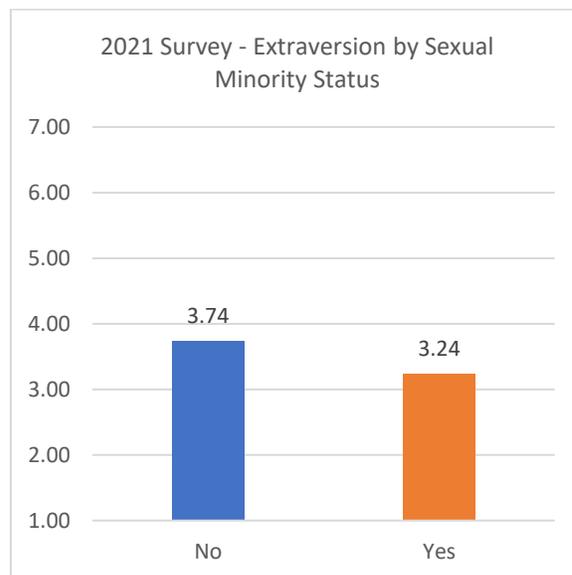
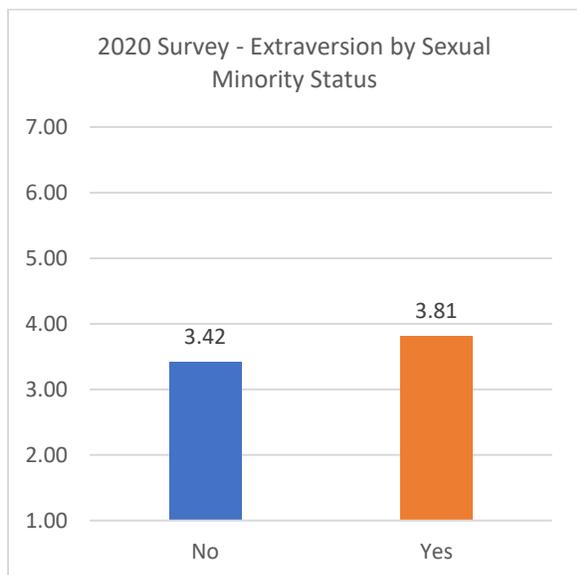
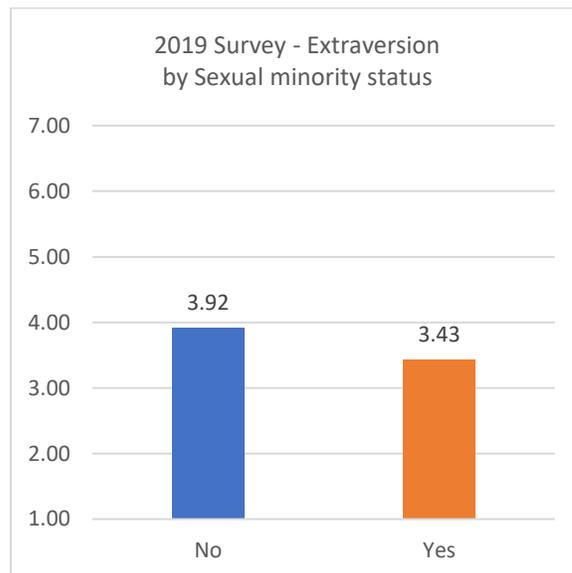
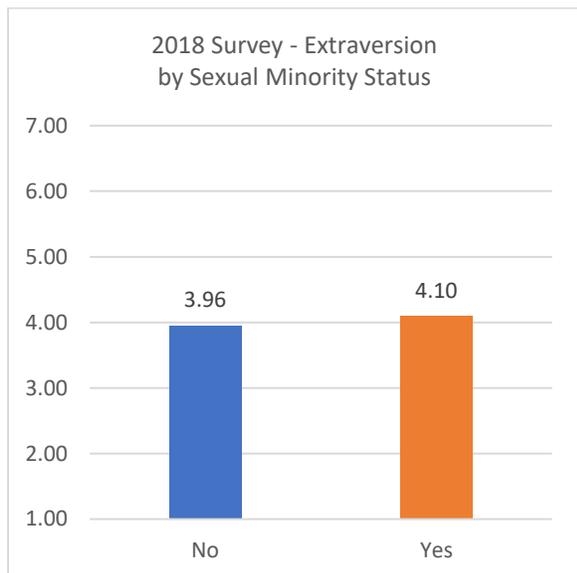
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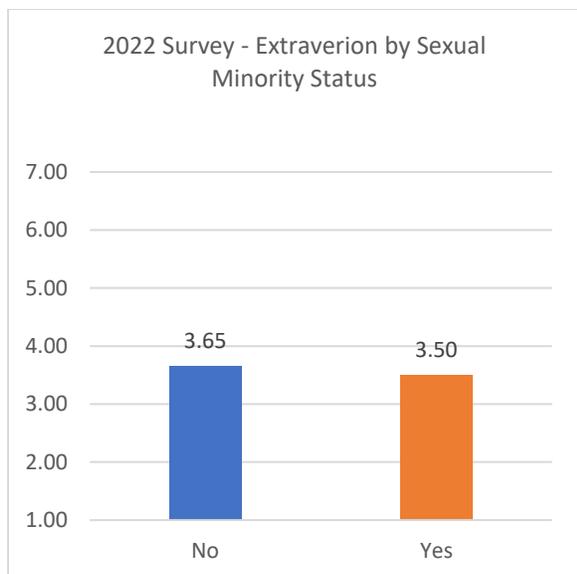
Gender



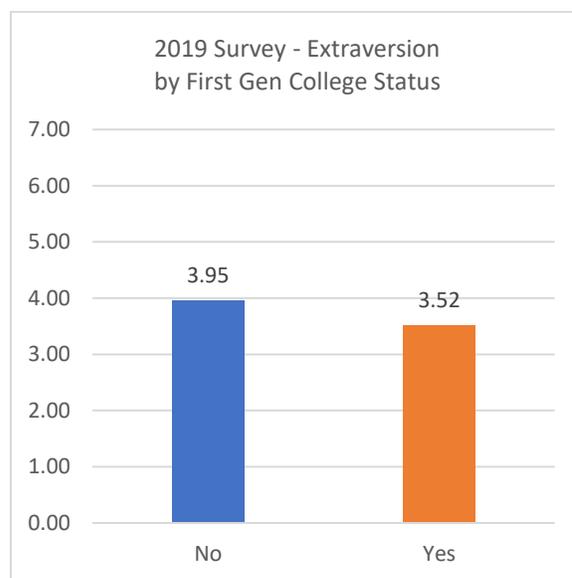
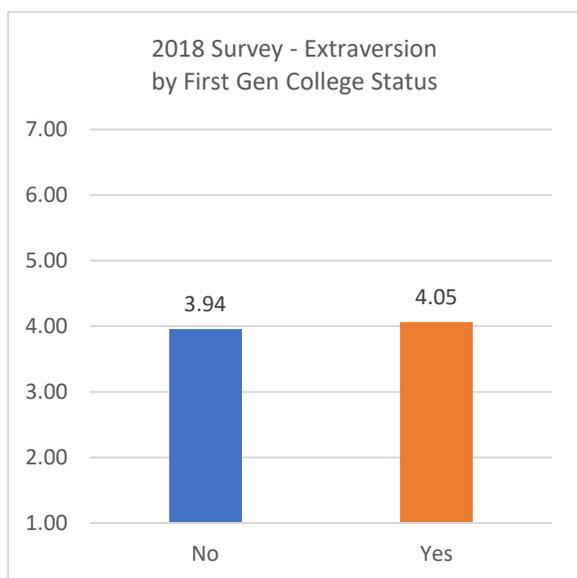


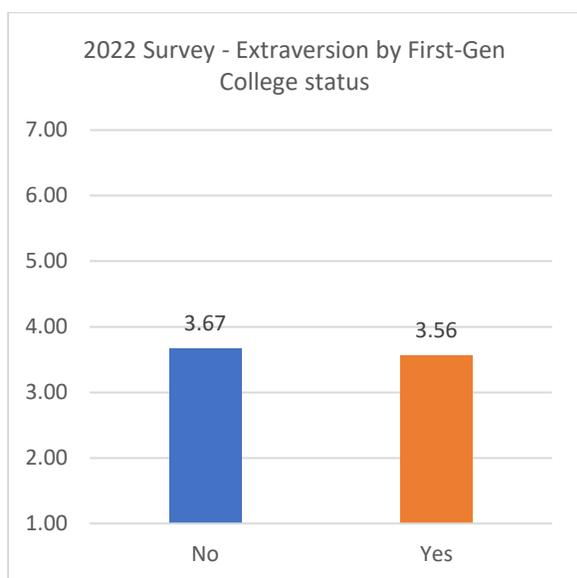
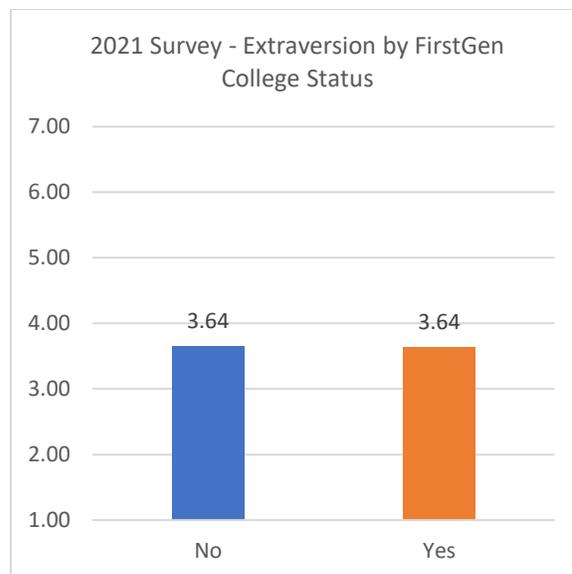
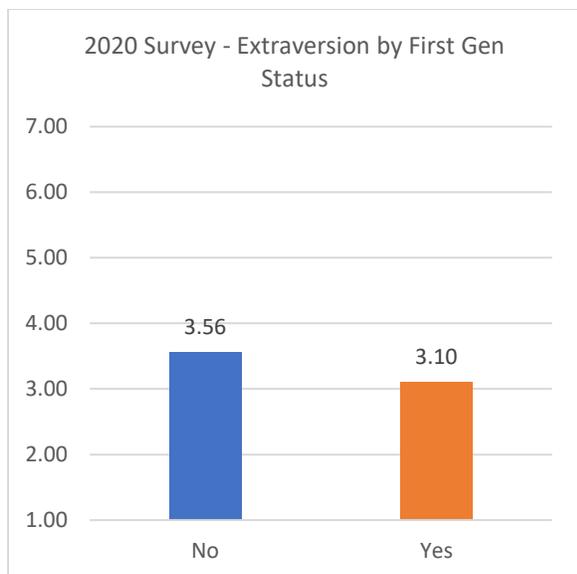
Sexual Minority Status



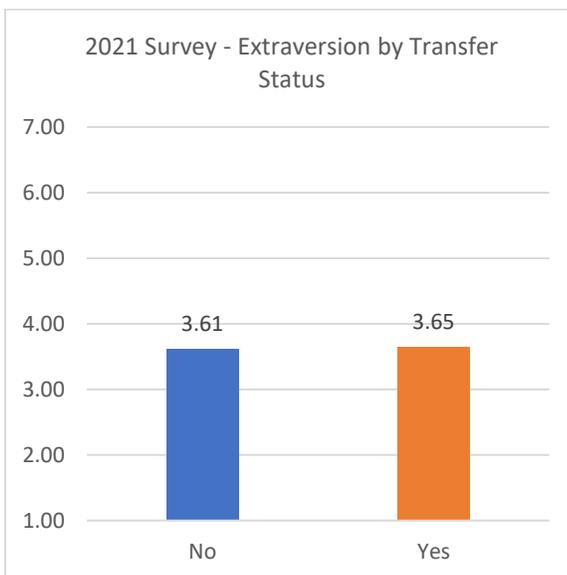
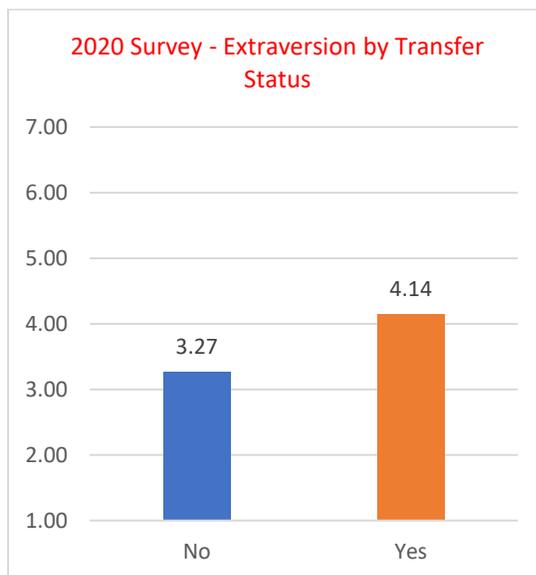
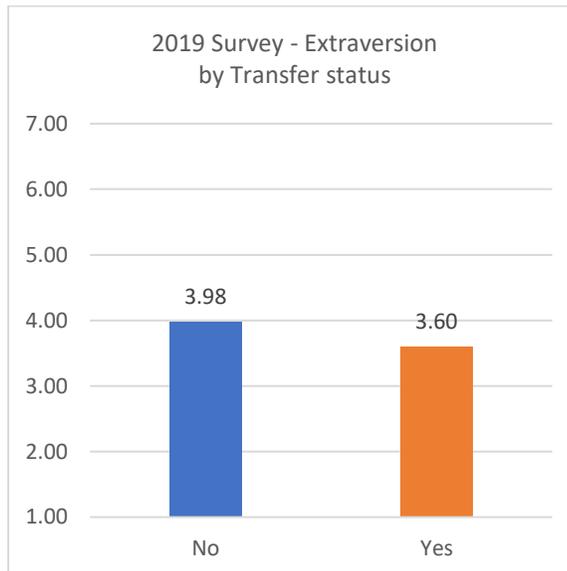
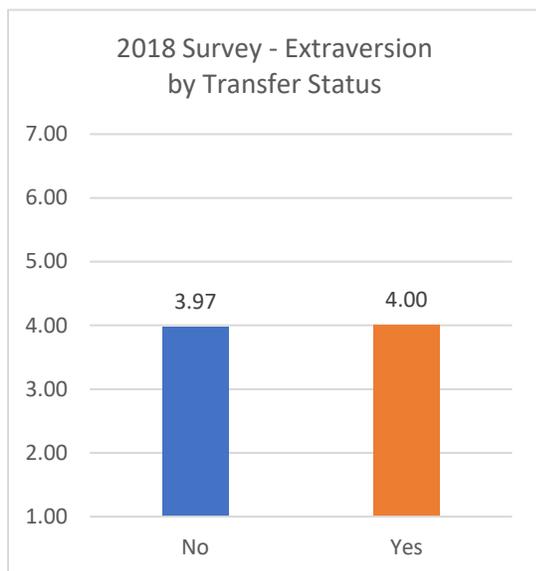


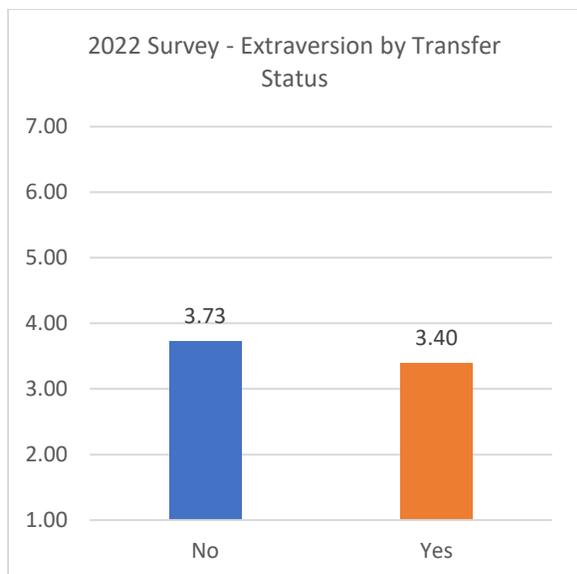
First-generation College Status



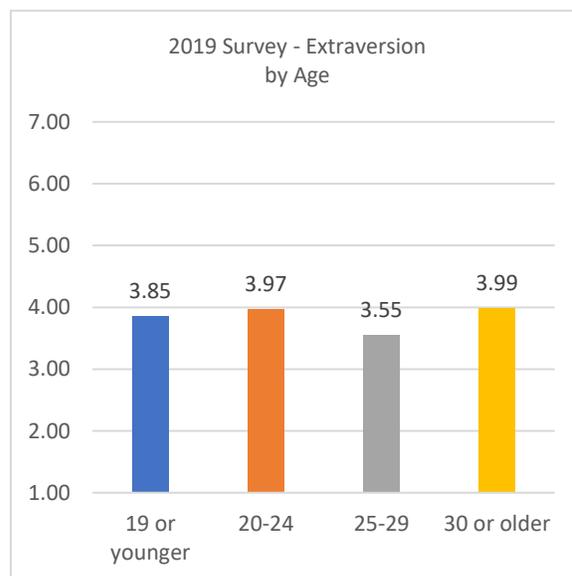
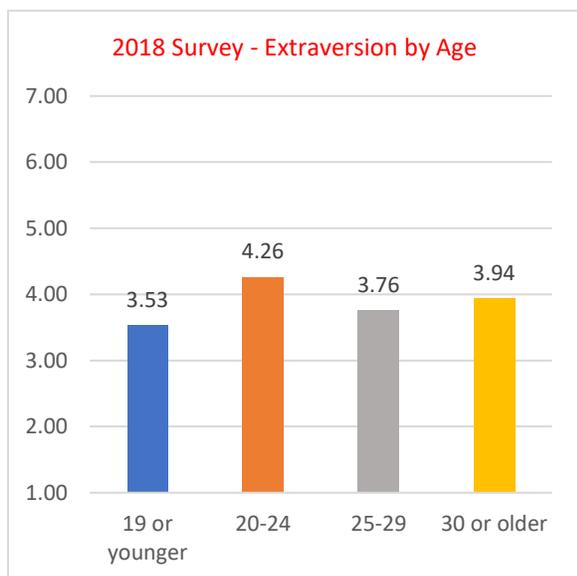


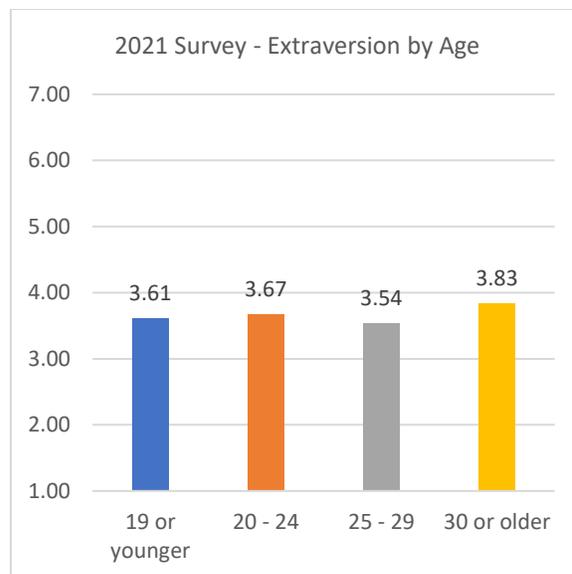
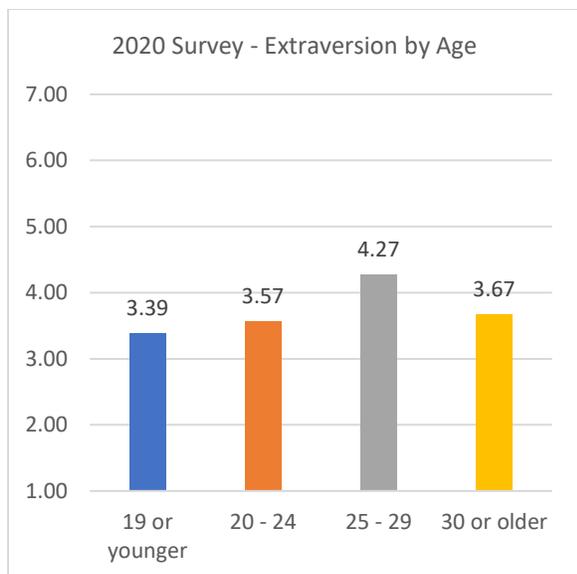
Transfer Status



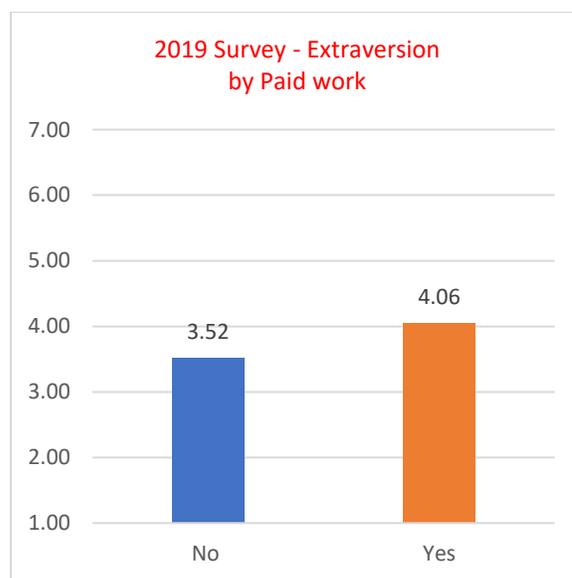
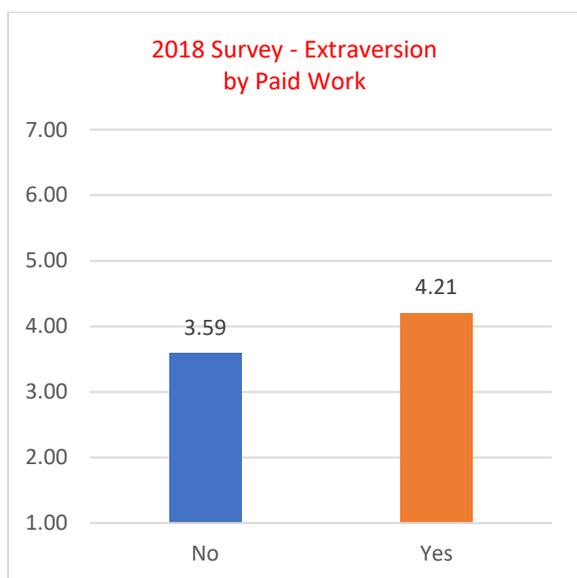


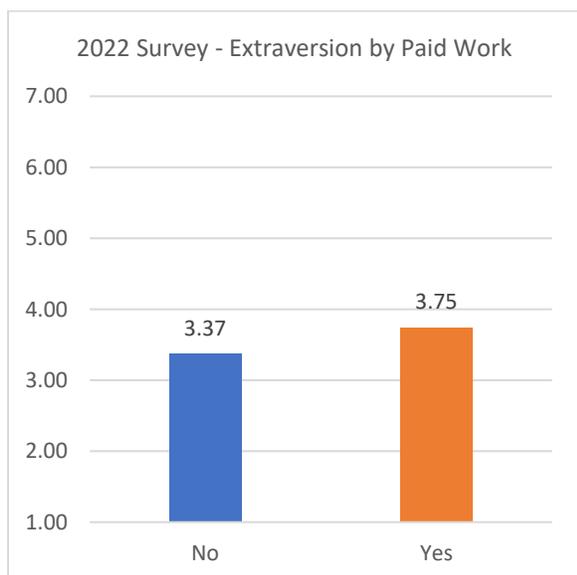
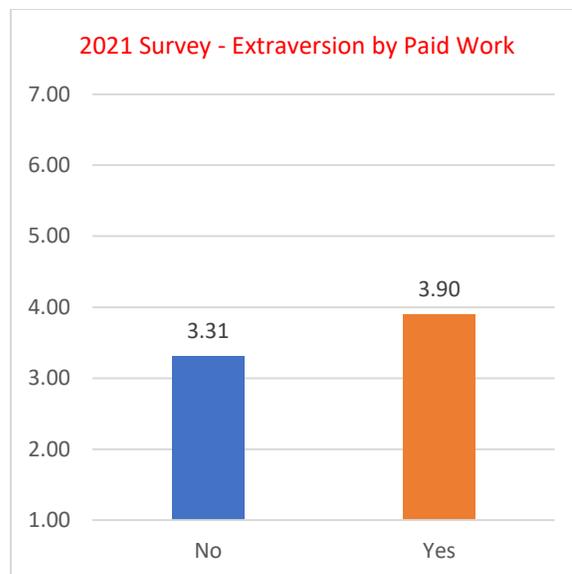
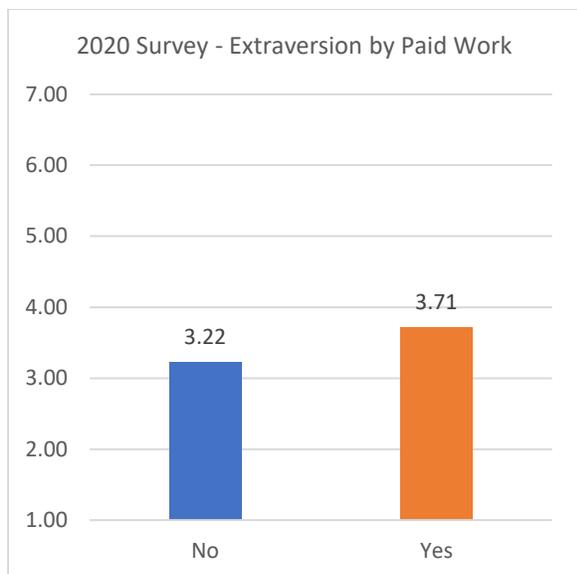
Age





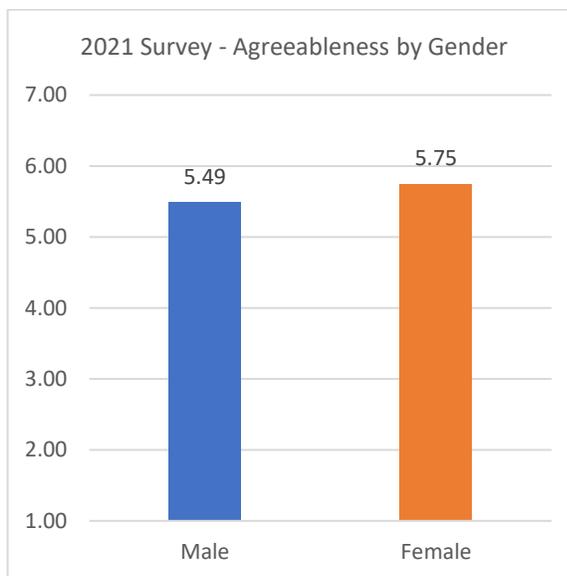
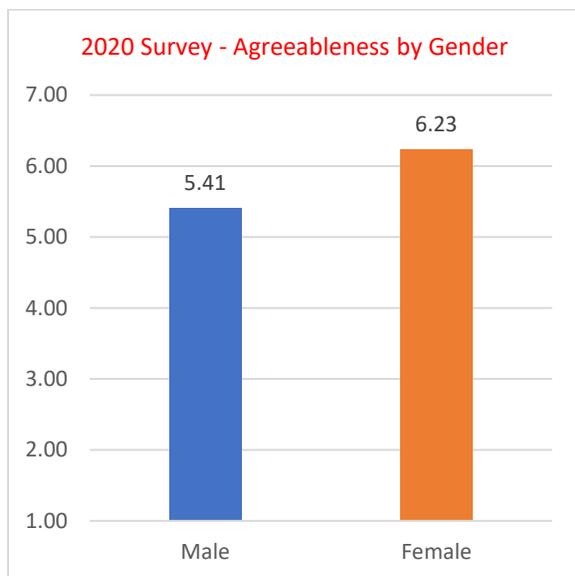
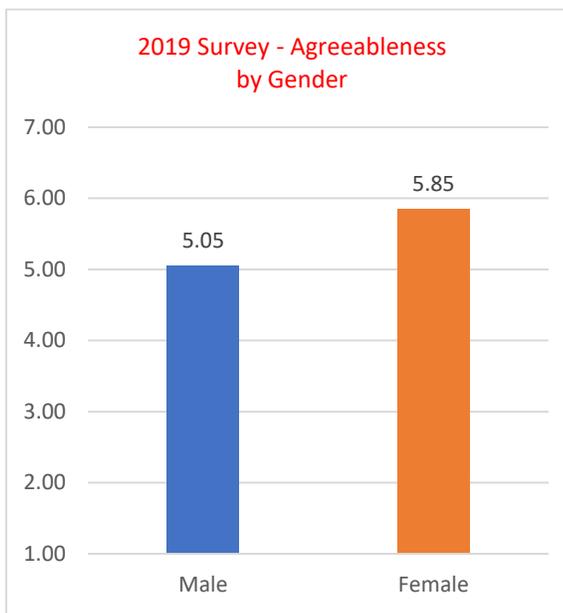
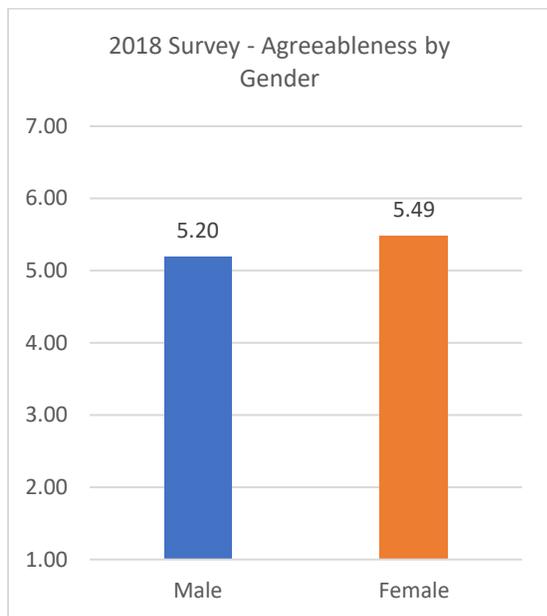
Employment status

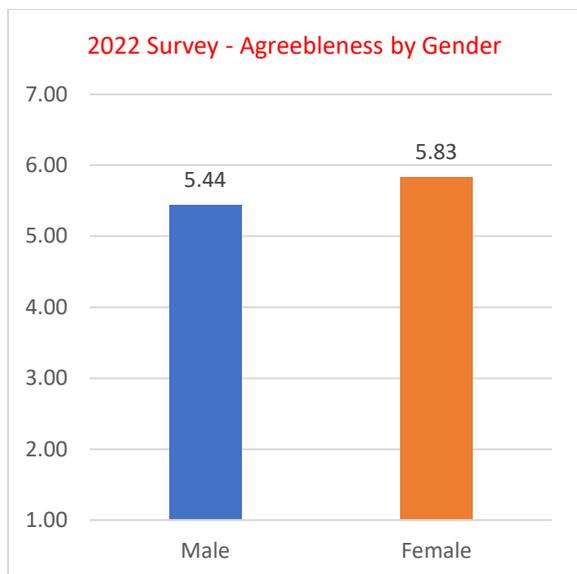




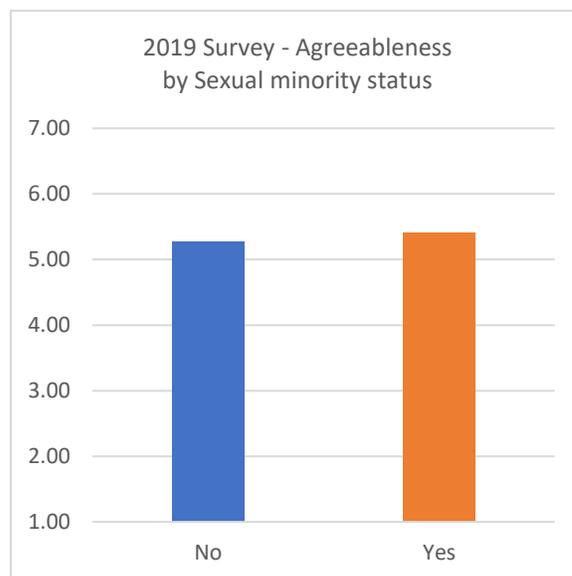
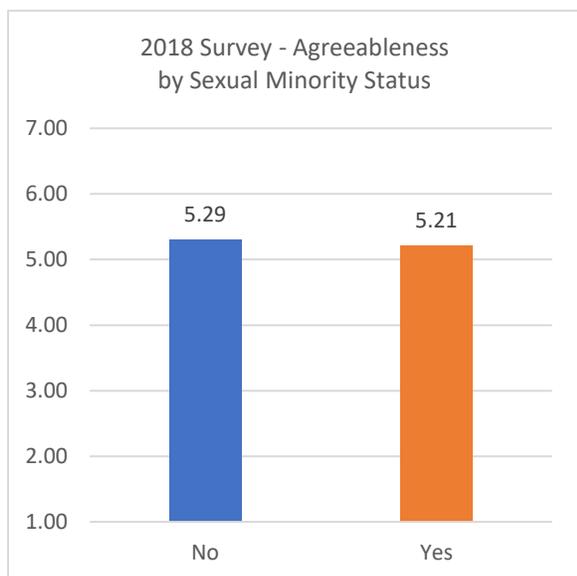
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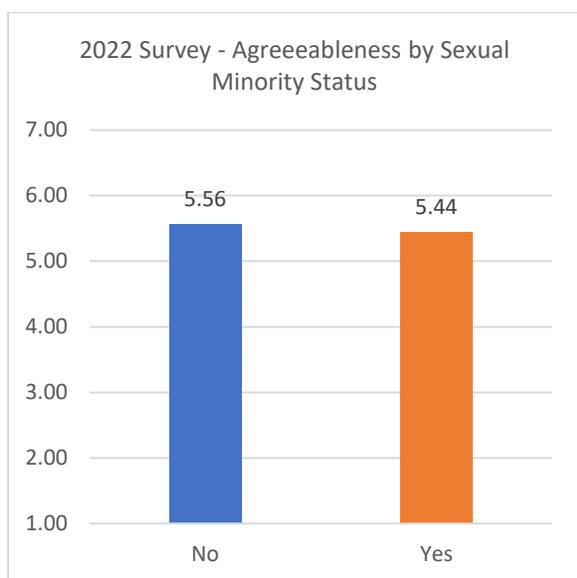
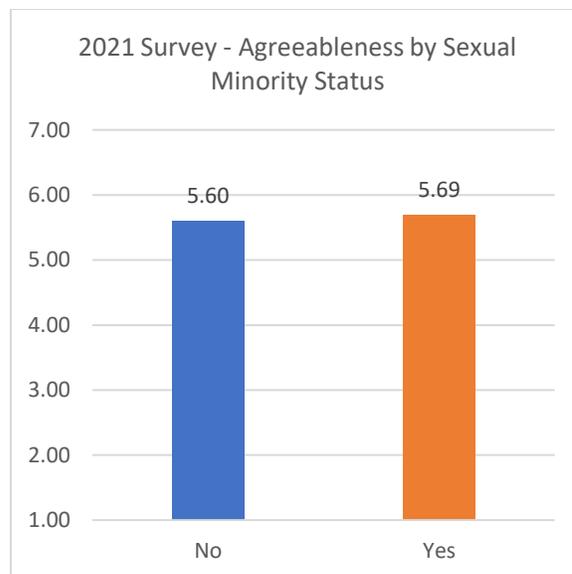
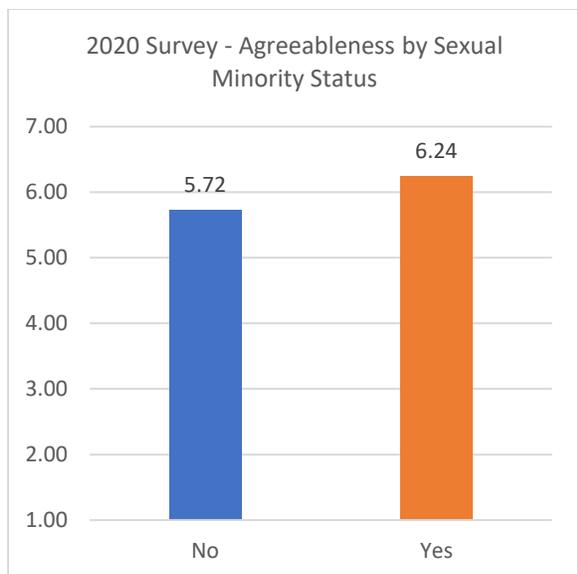
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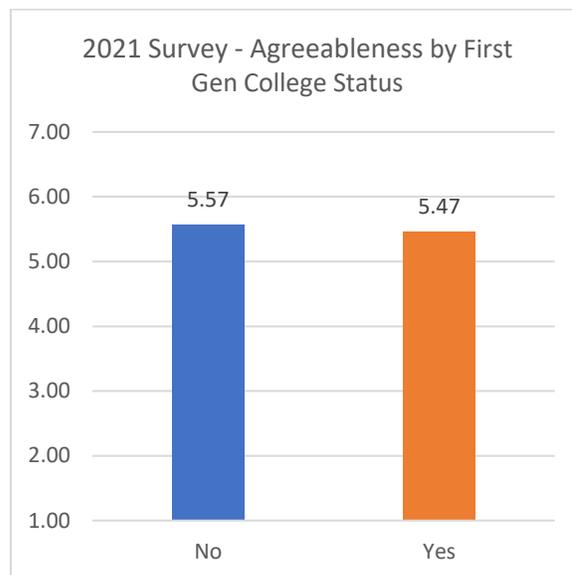
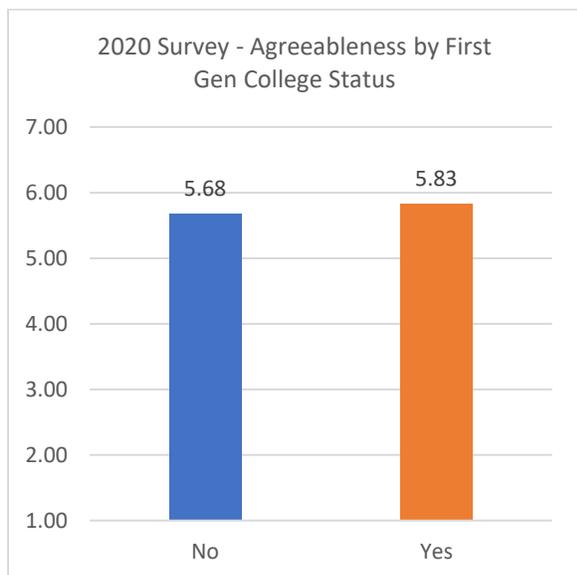
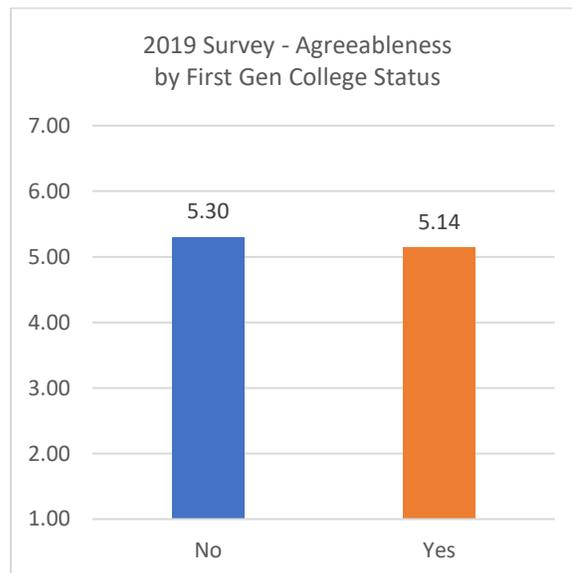
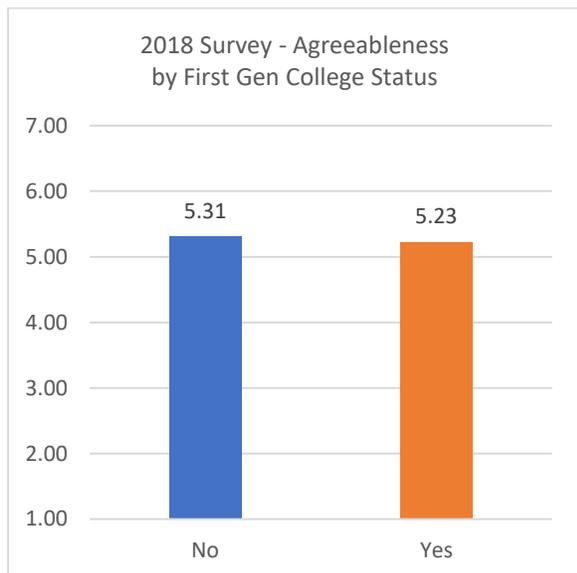


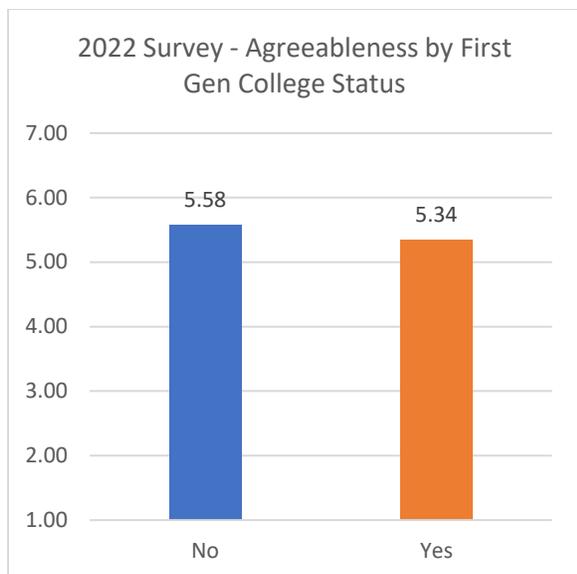
Sexual Minority Status



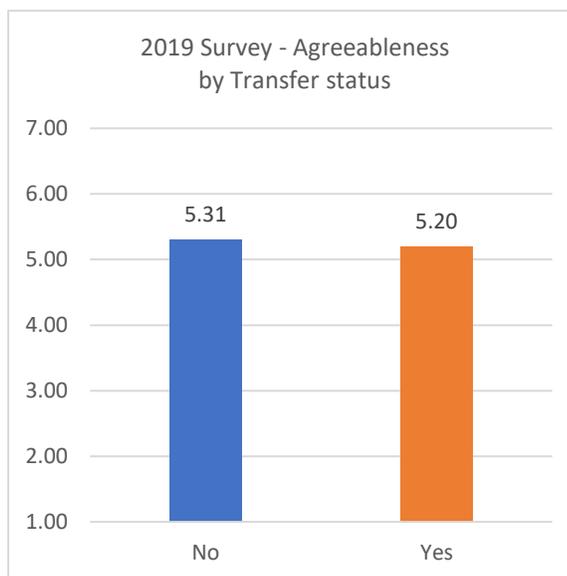
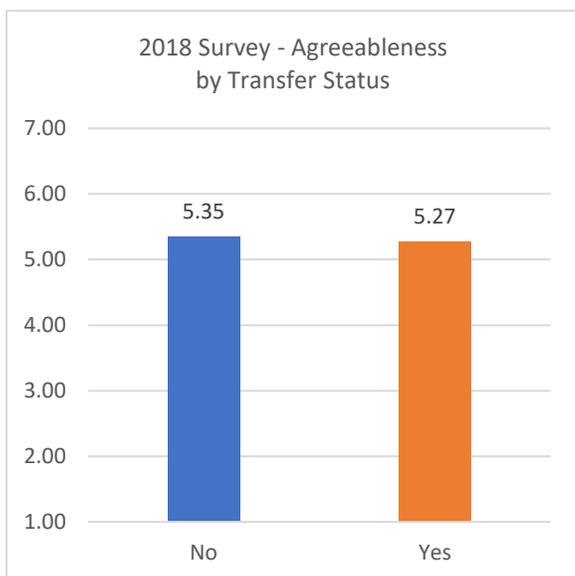


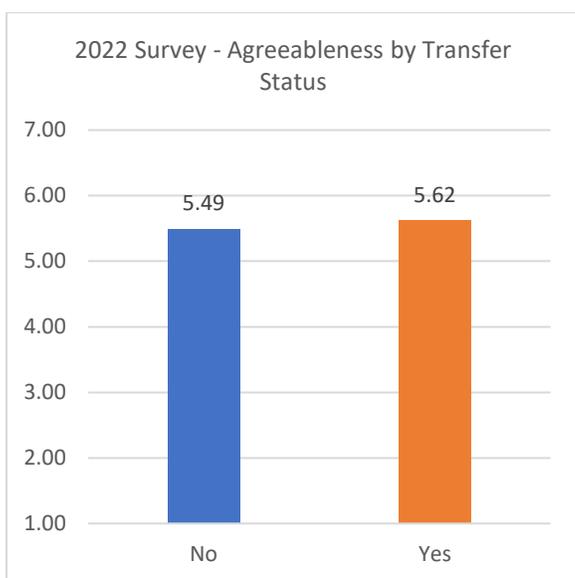
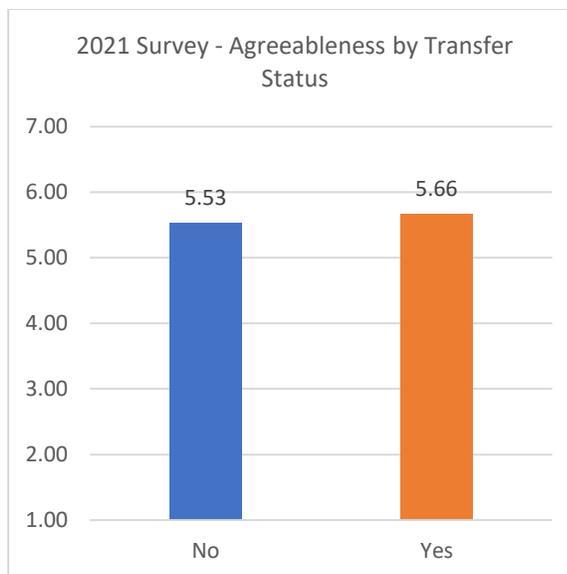
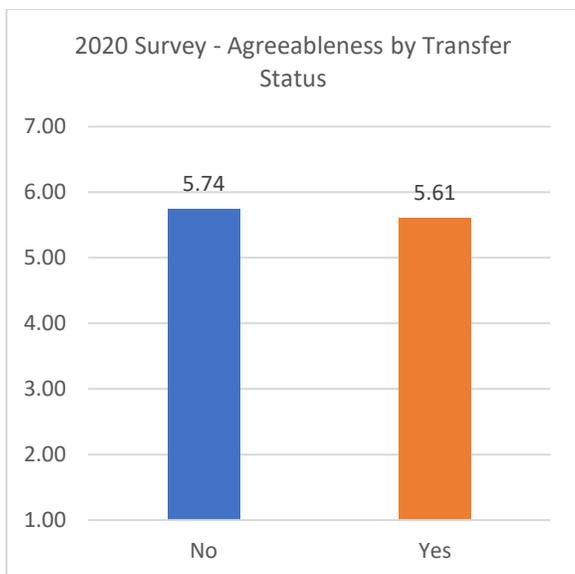
First-generation College Status



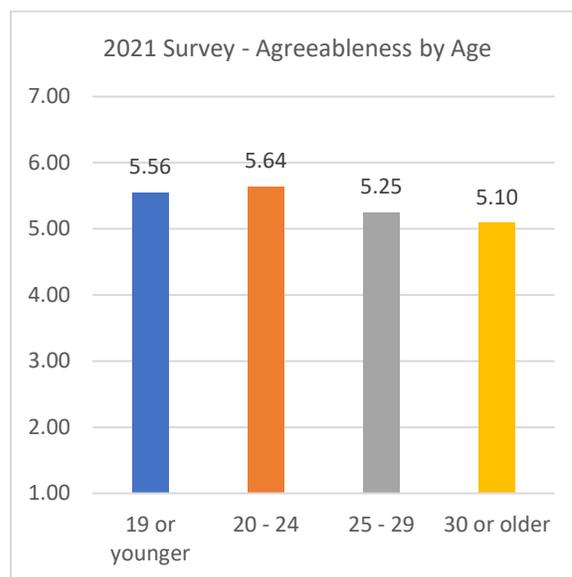
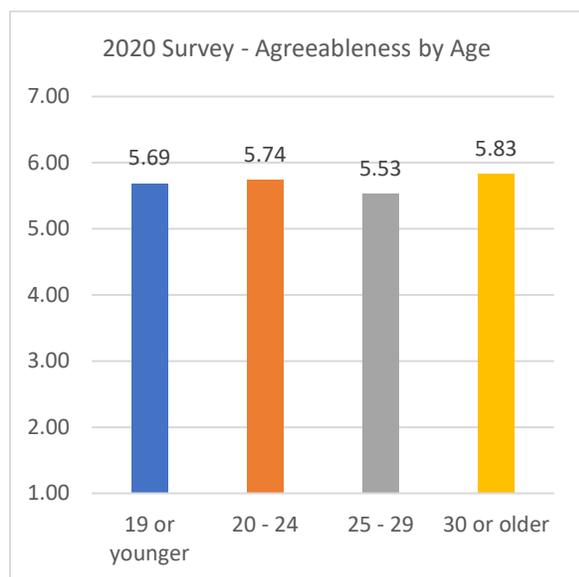
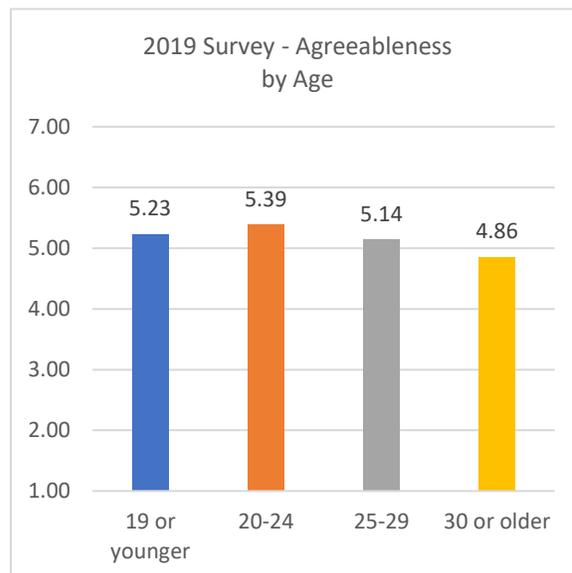
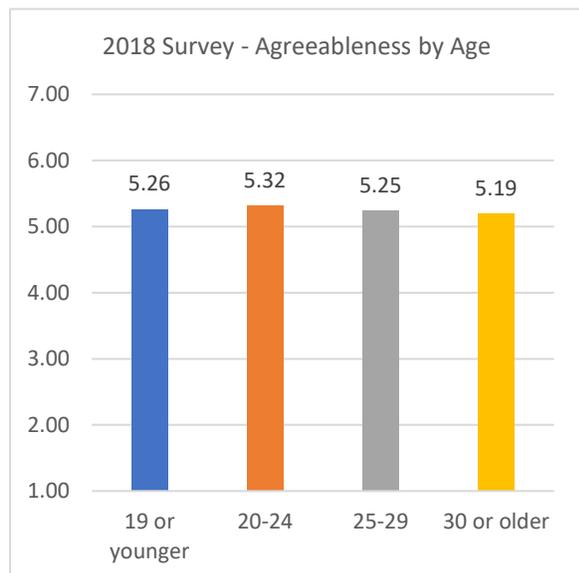


Transfer Status

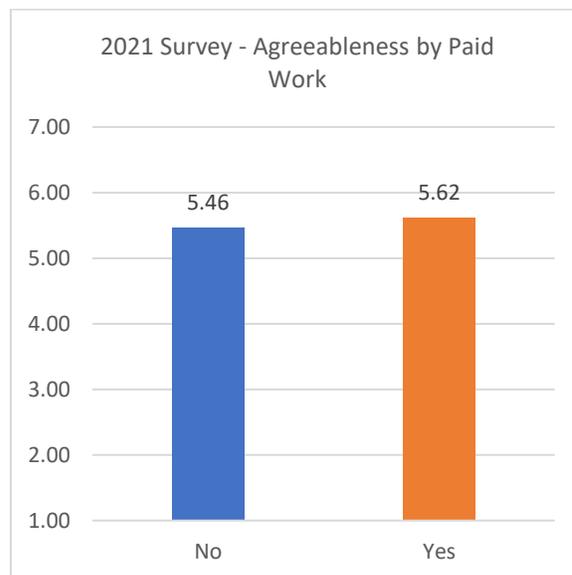
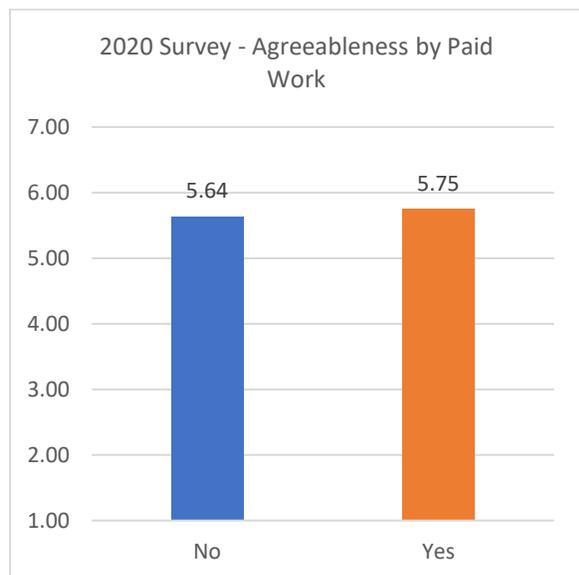
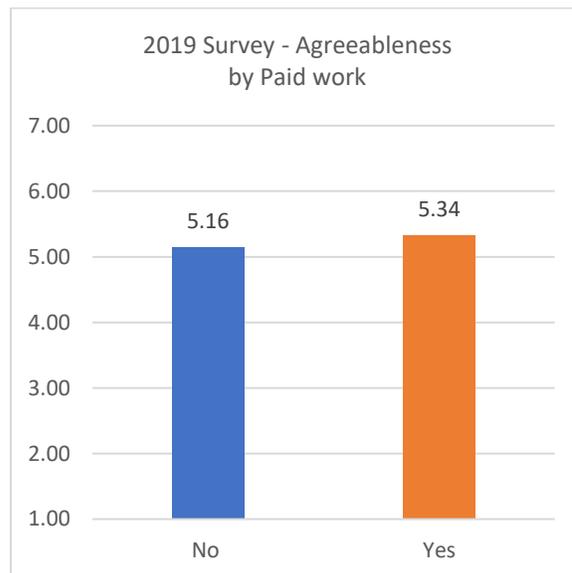
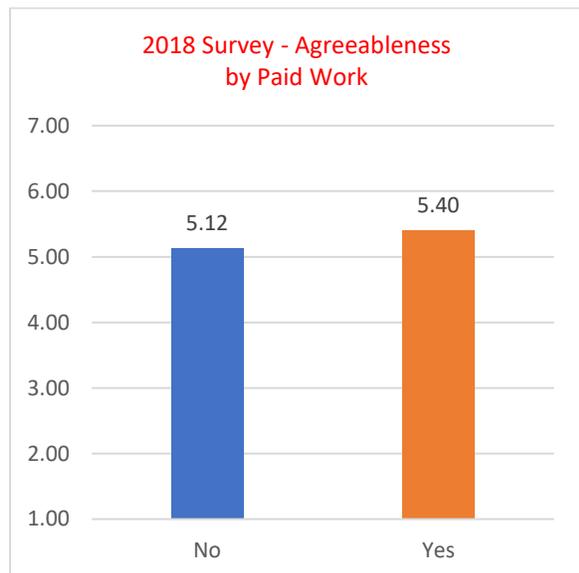


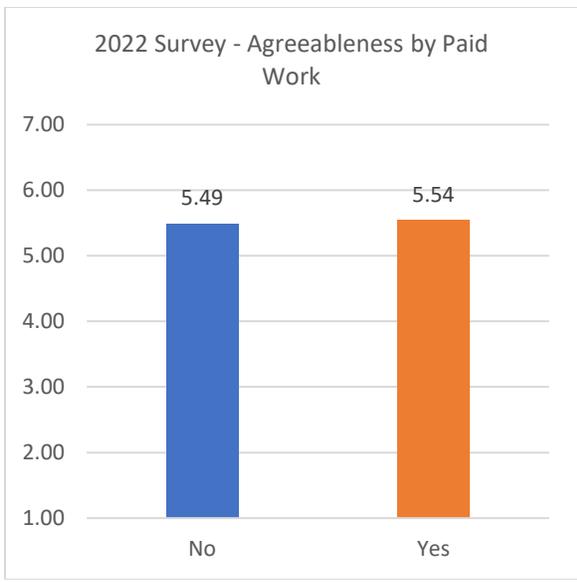


Age



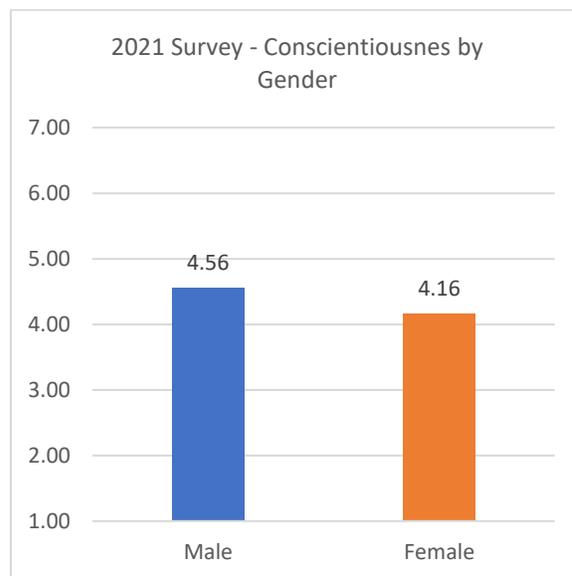
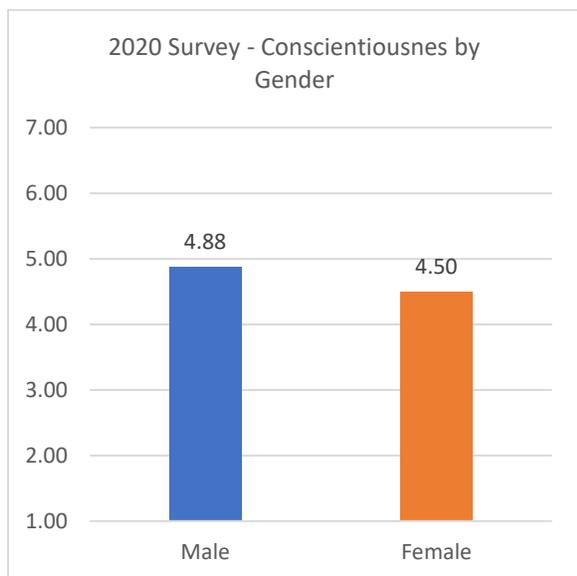
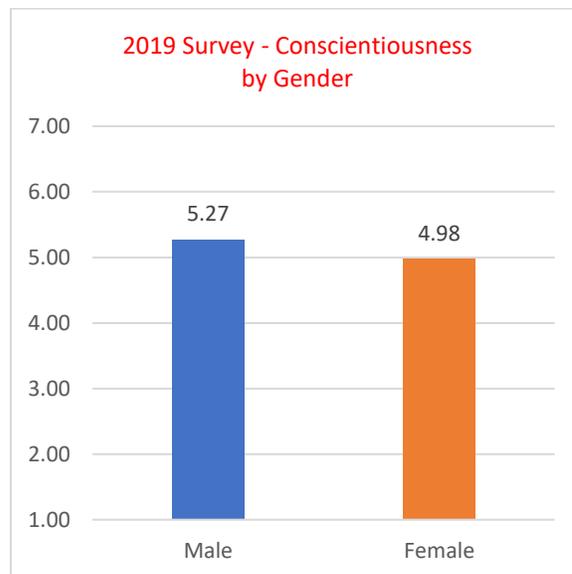
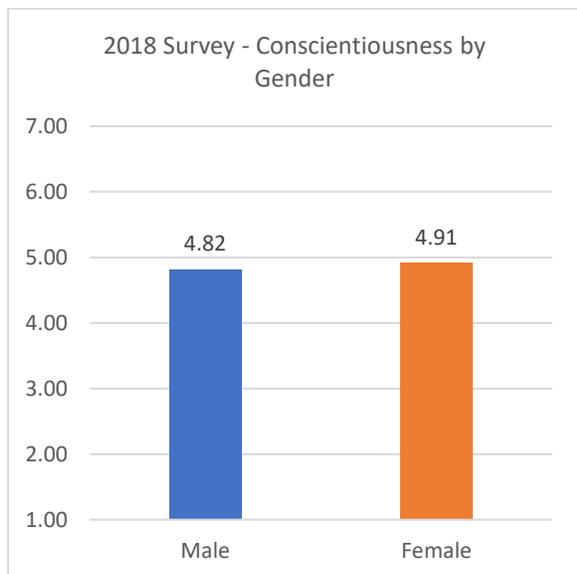
Employment status

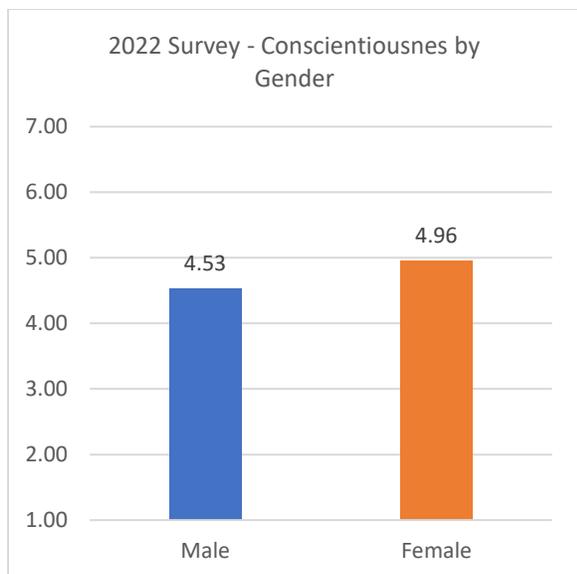




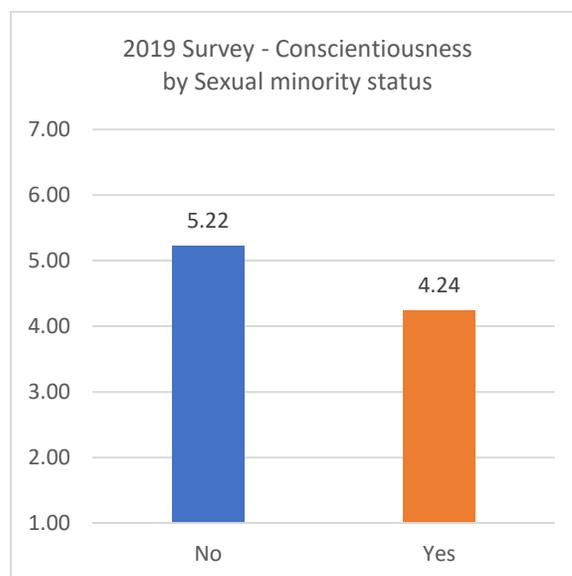
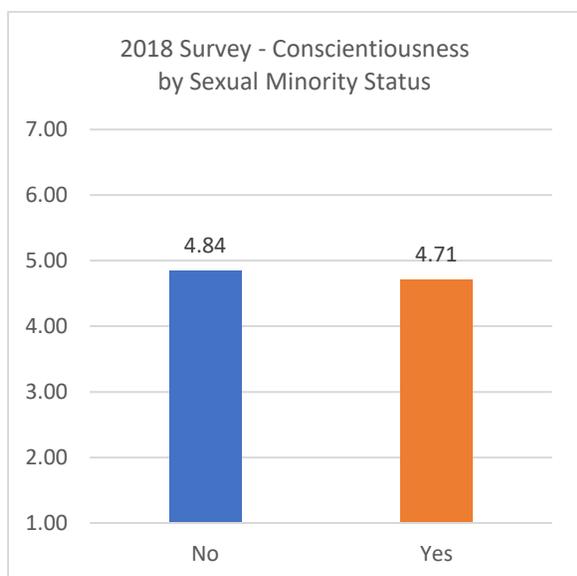
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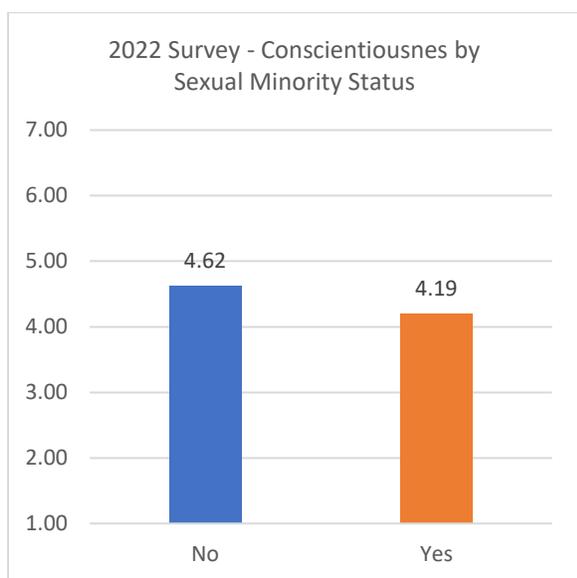
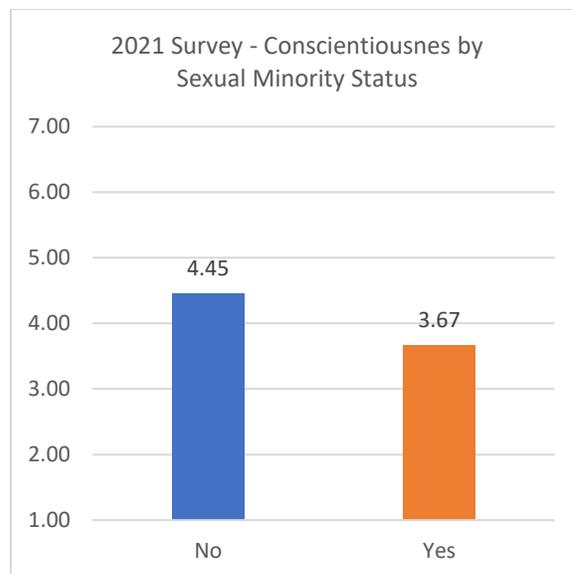
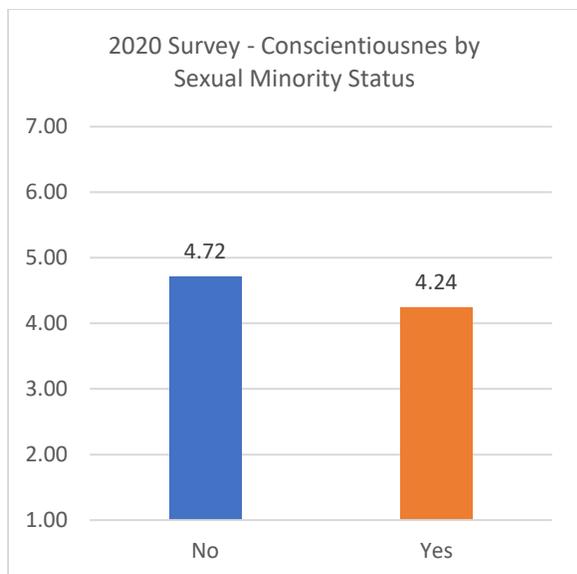
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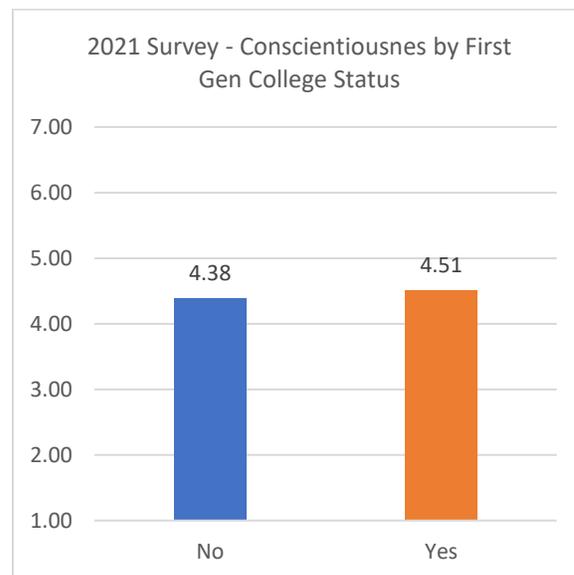
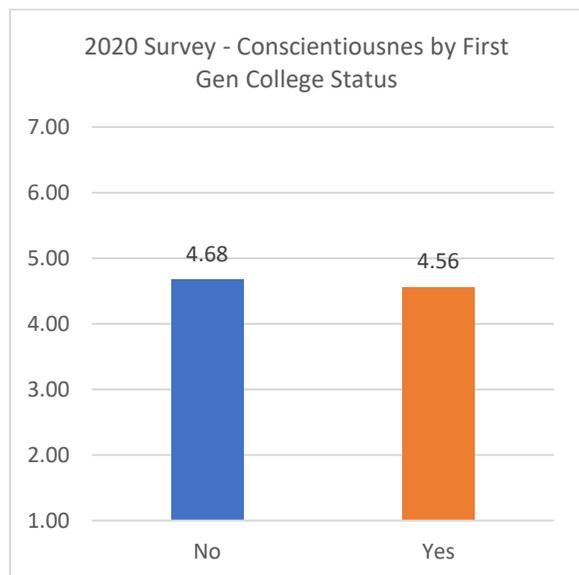
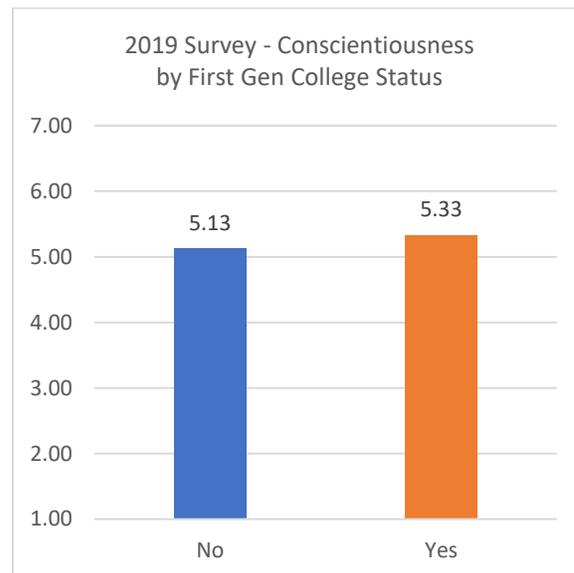
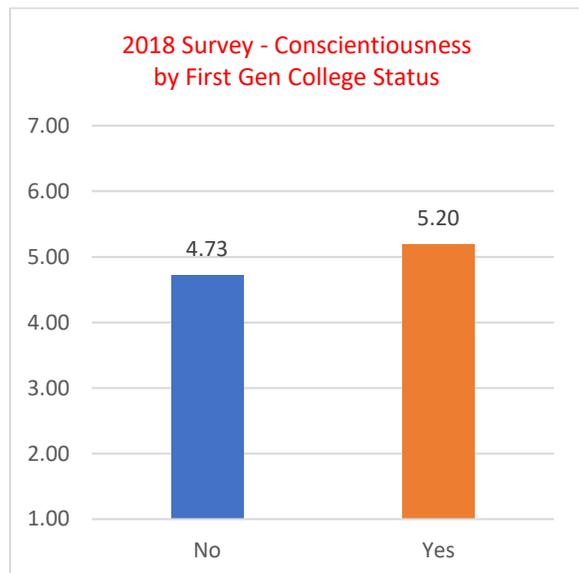


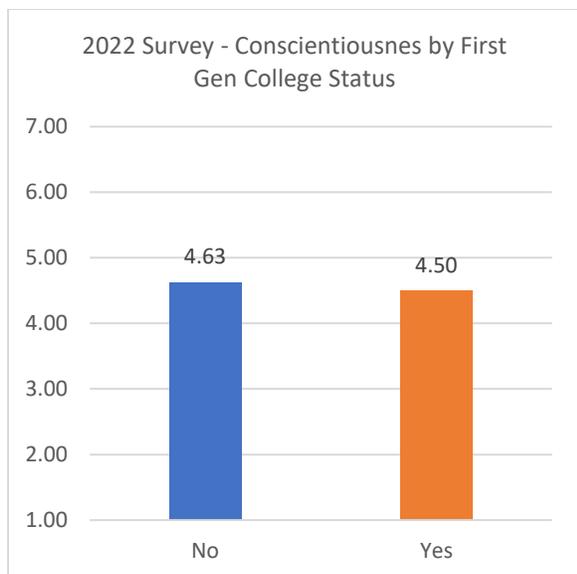
Sexual Minority Status



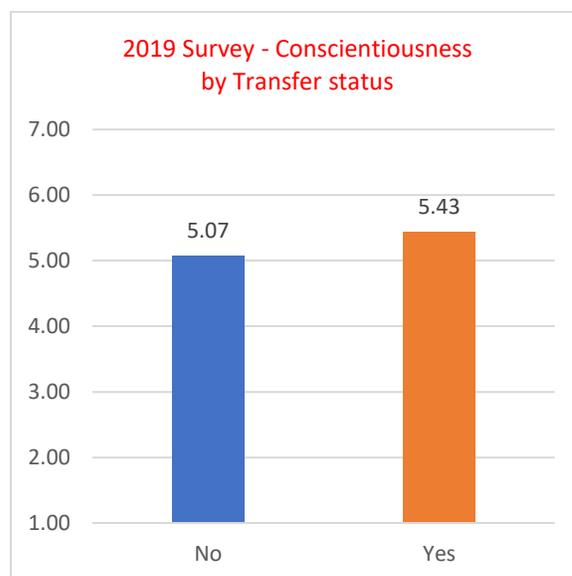
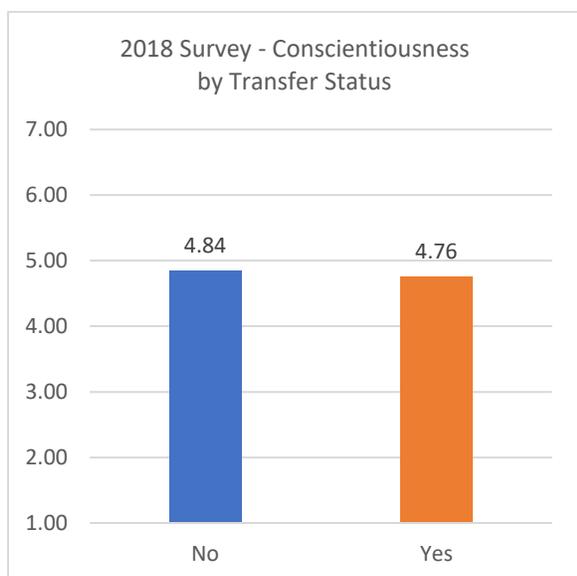


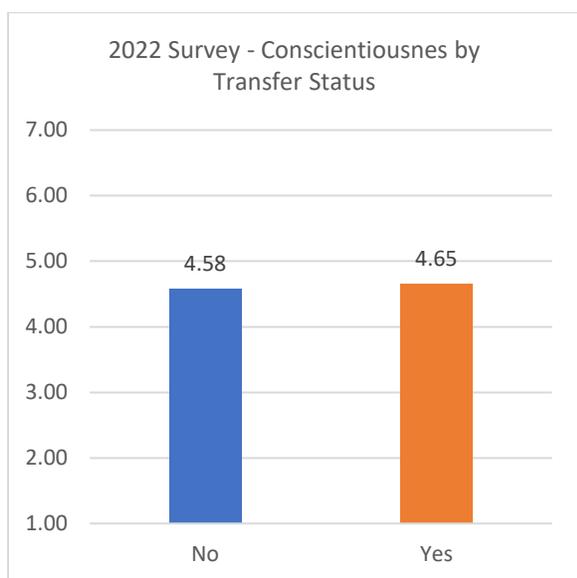
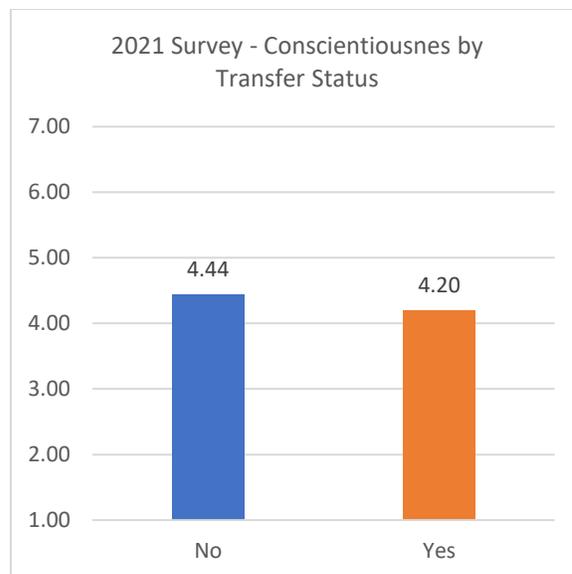
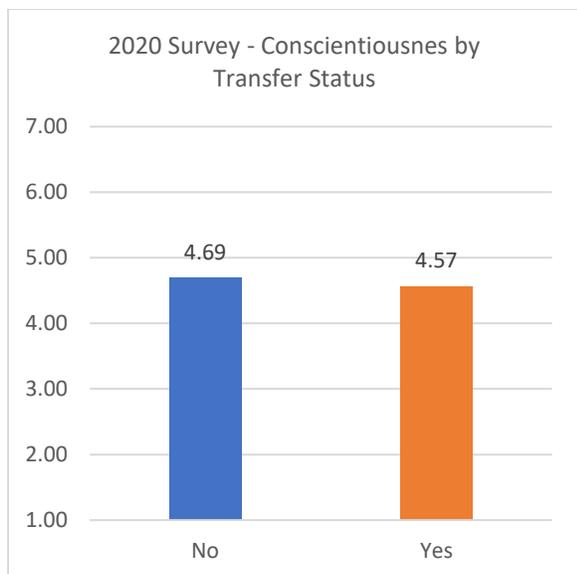
First-generation College Status



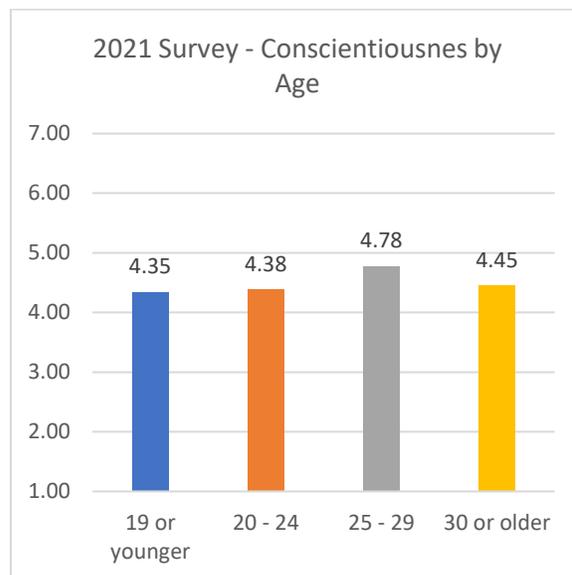
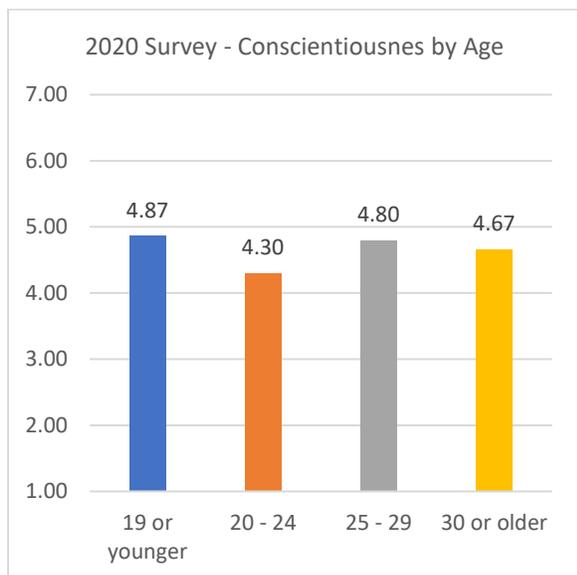
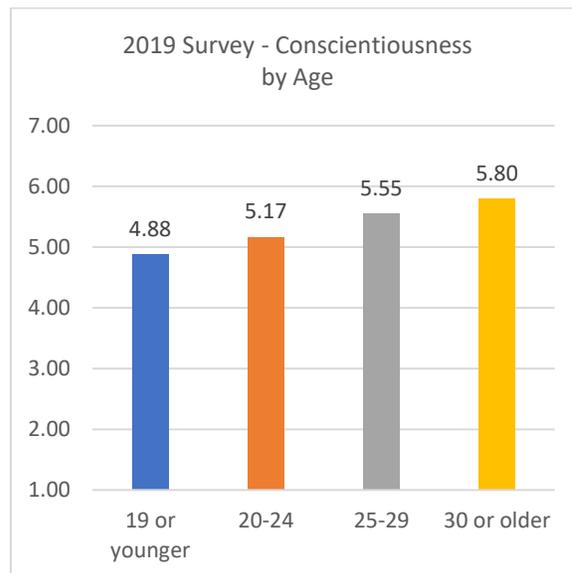
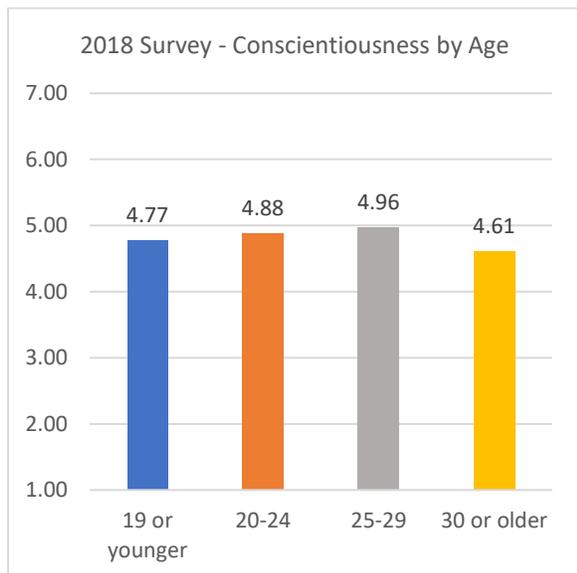


Transfer Status

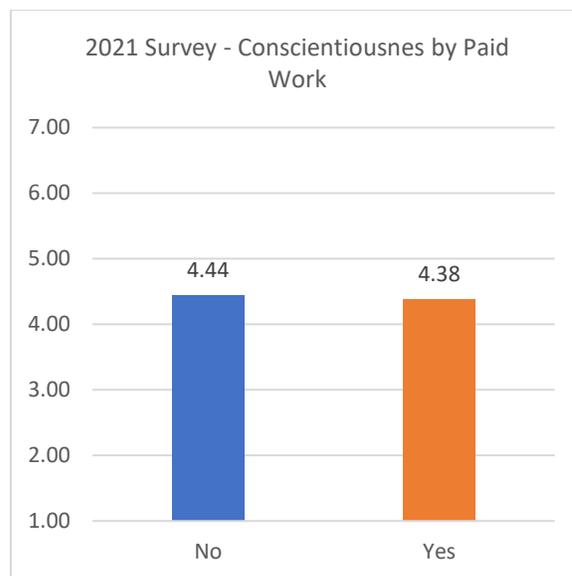
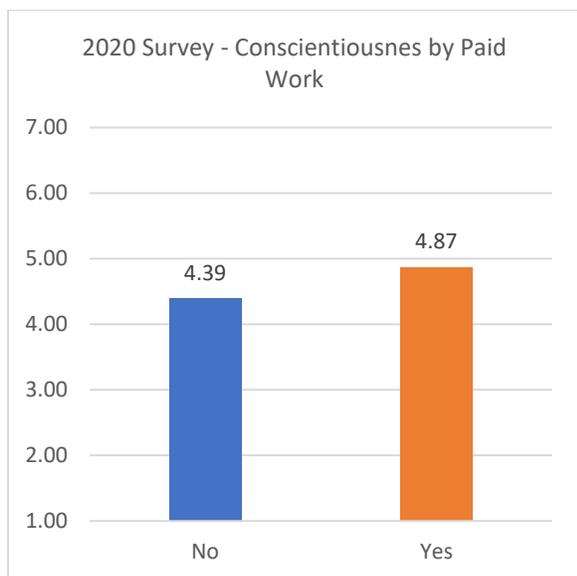
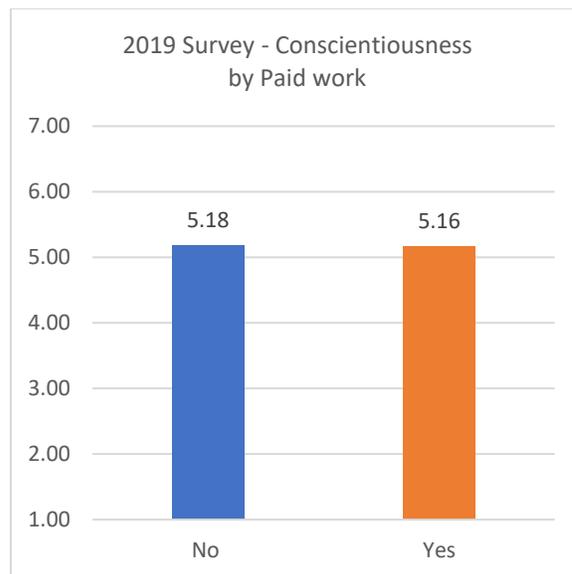
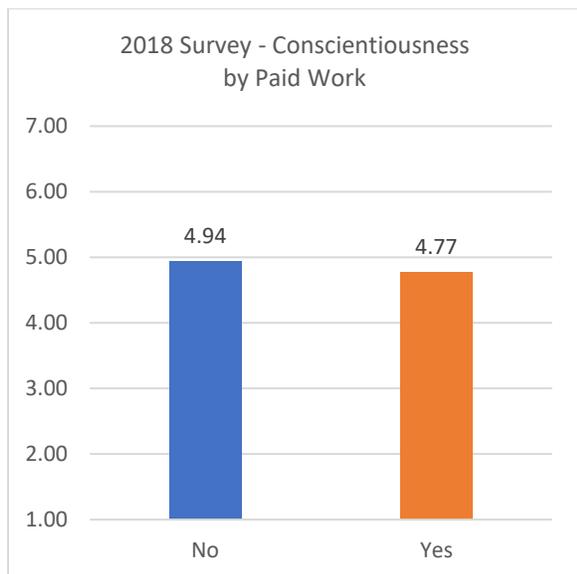


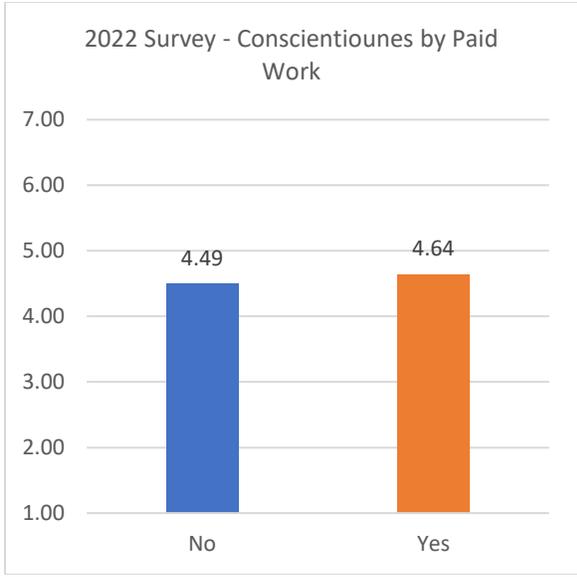


Age



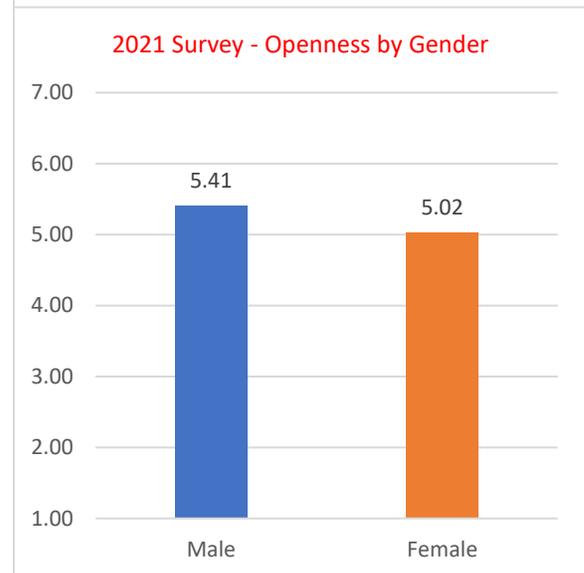
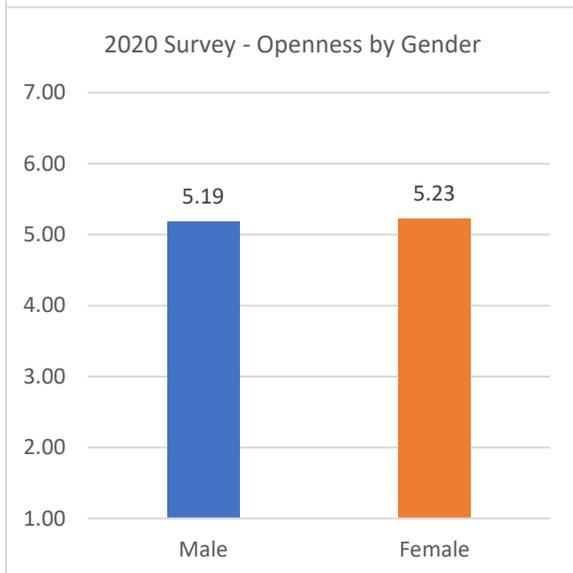
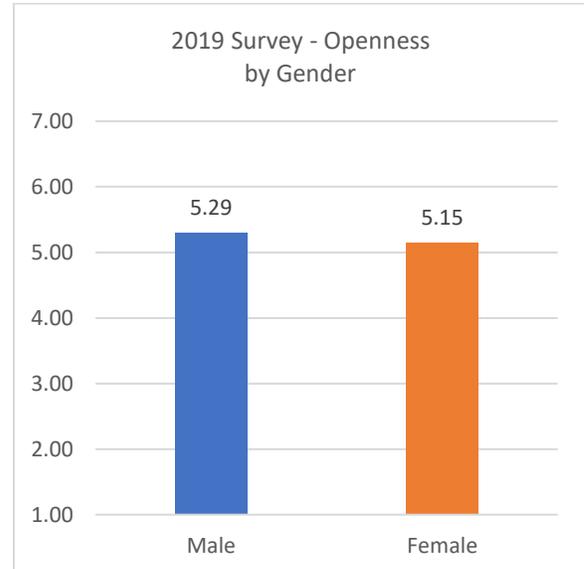
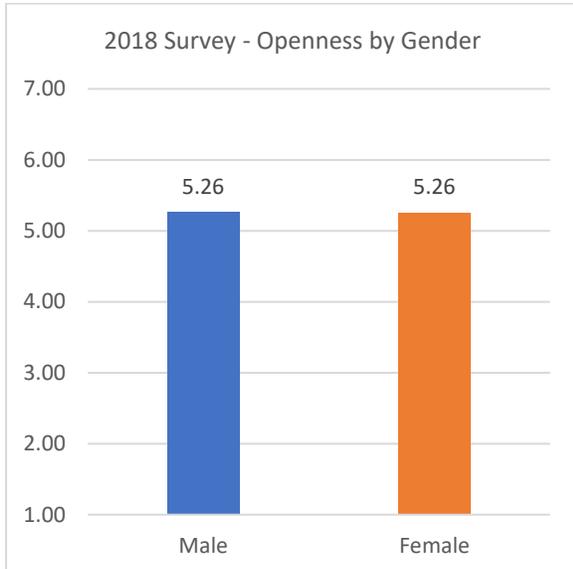
Employment status

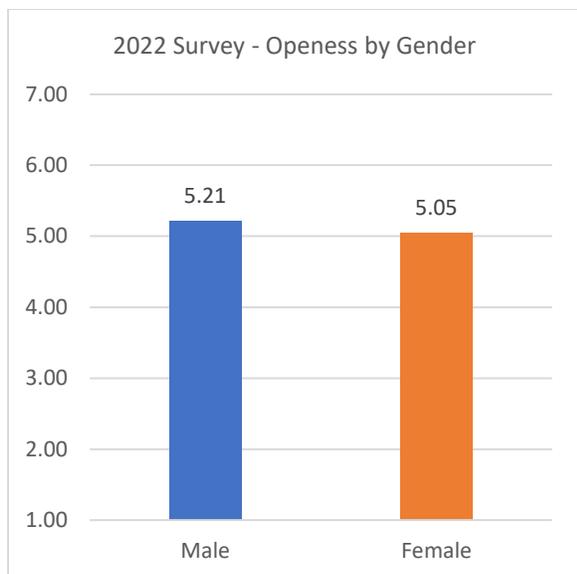




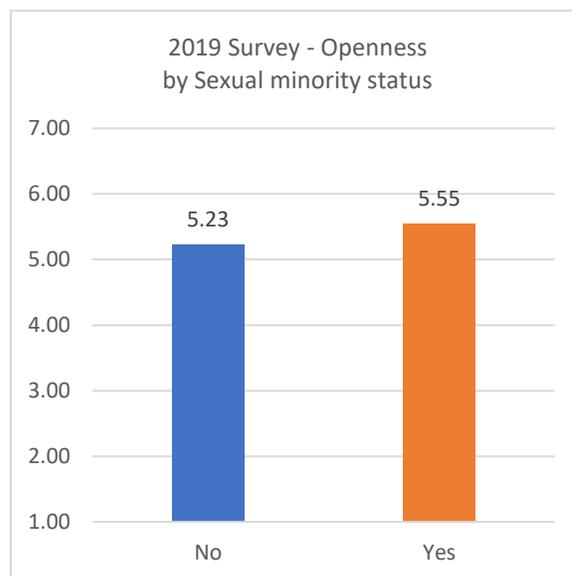
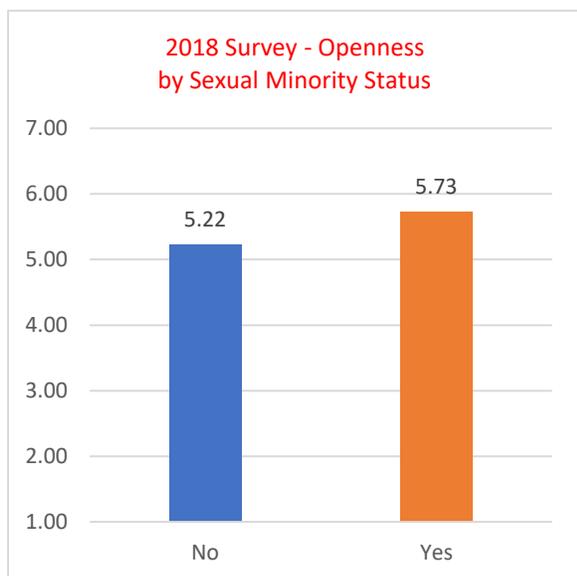
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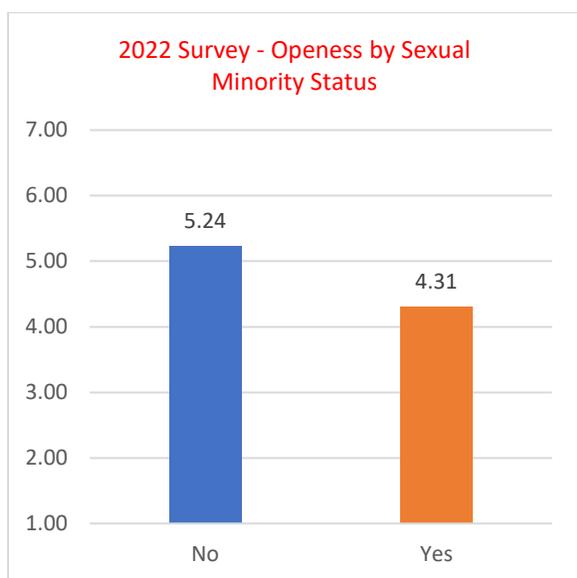
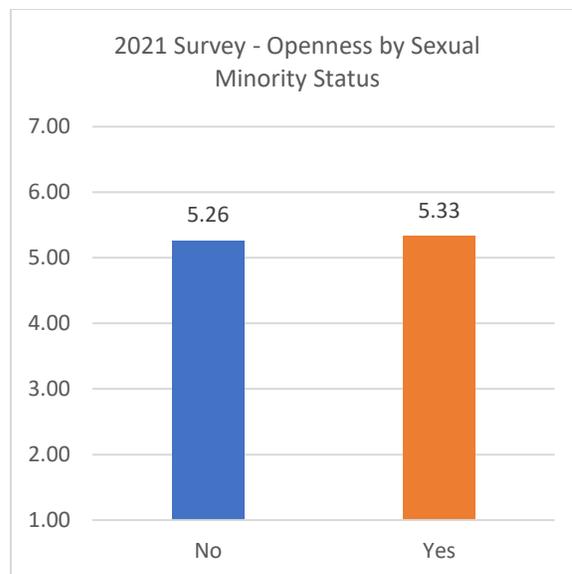
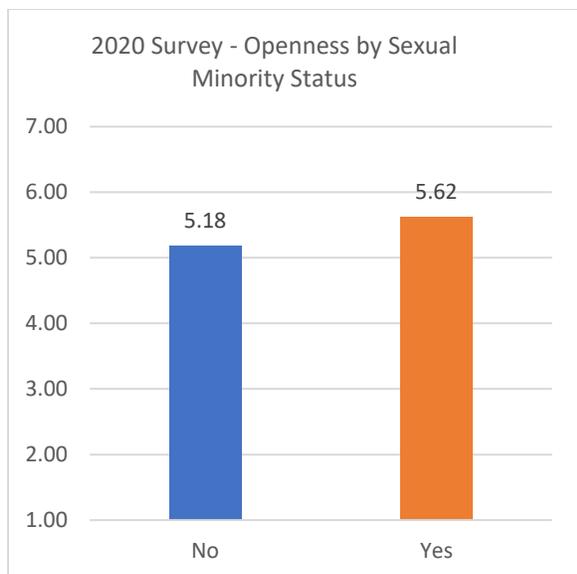
Gender



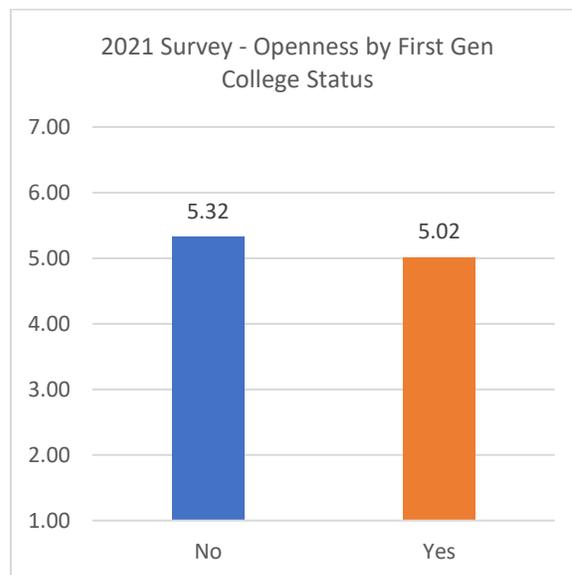
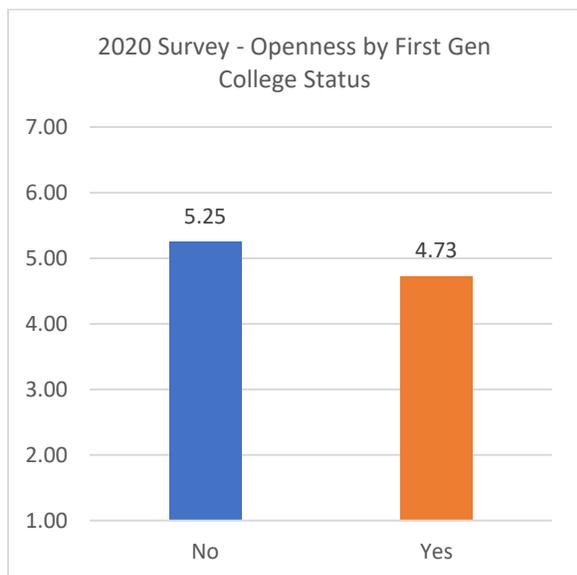
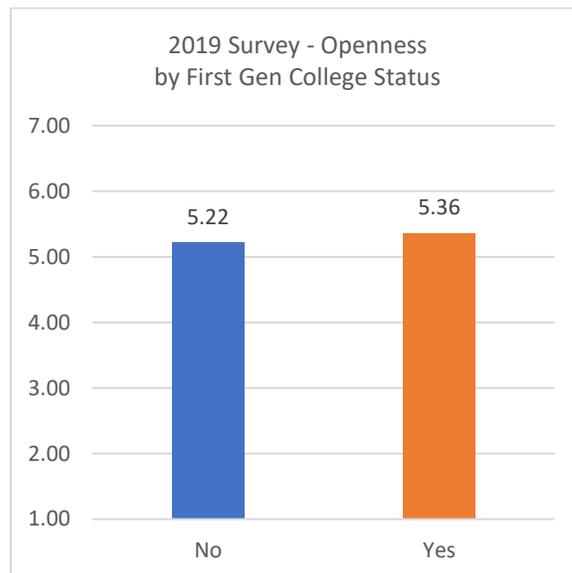
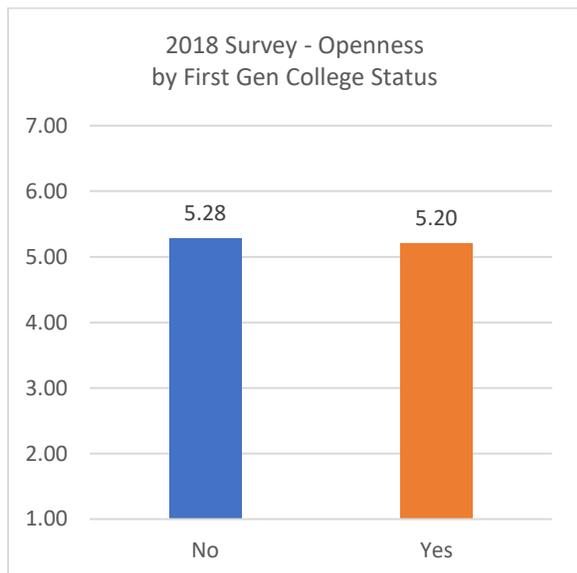


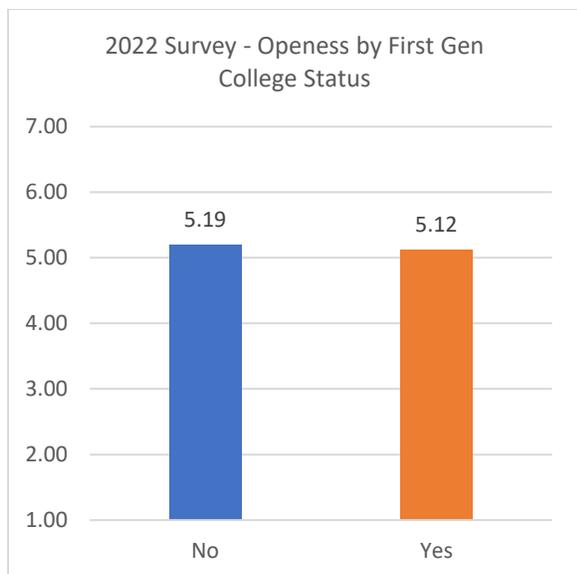
Sexual Minority Status



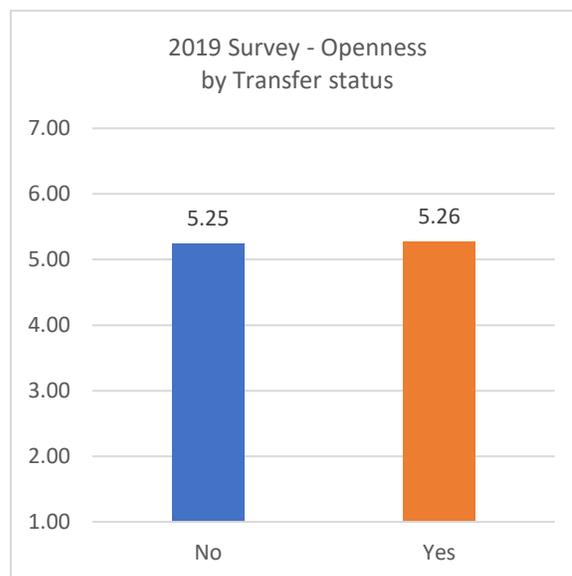
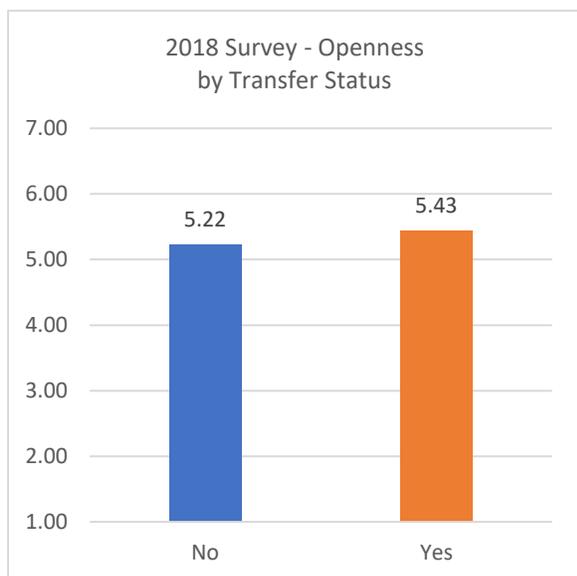


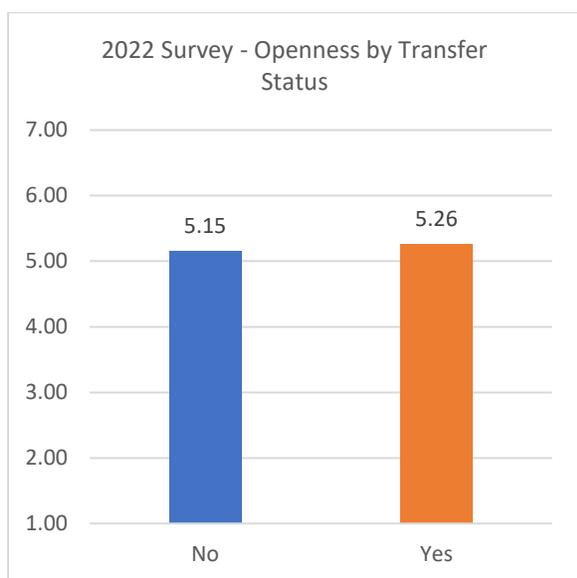
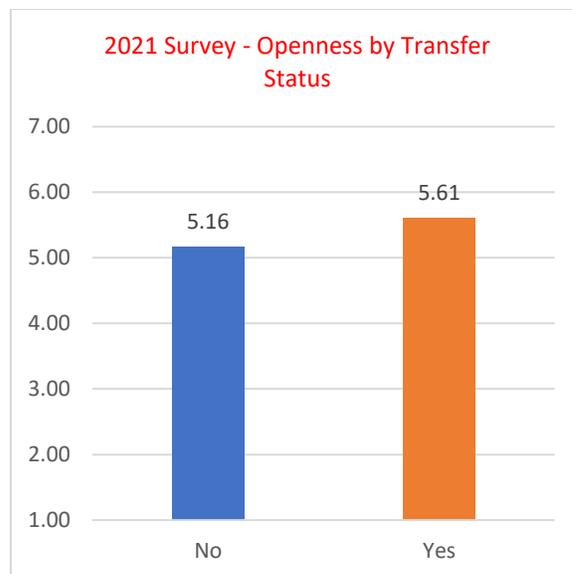
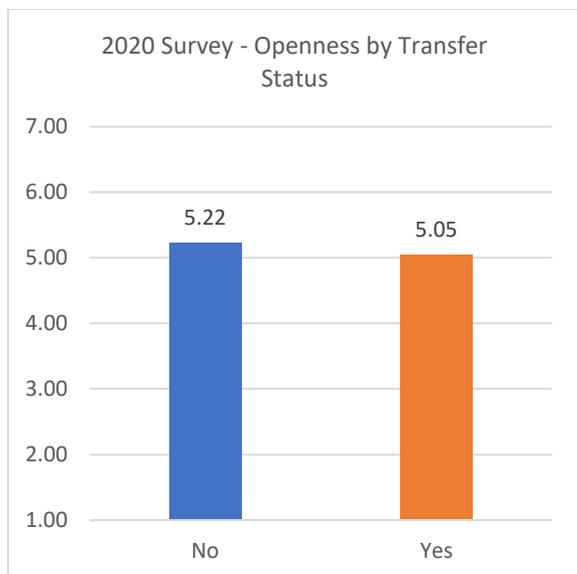
First-generation College Status



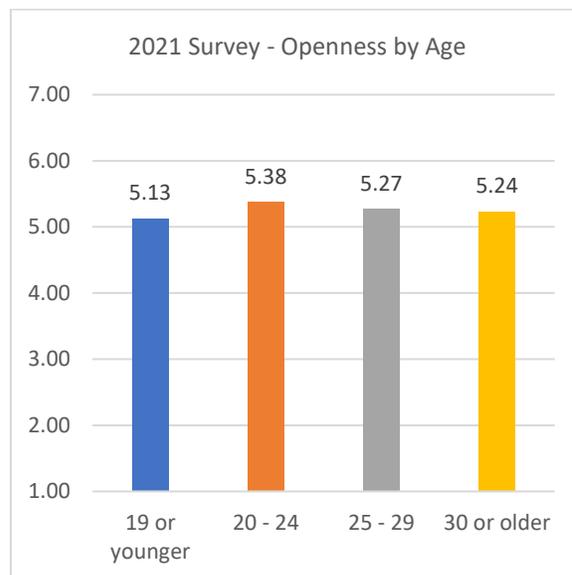
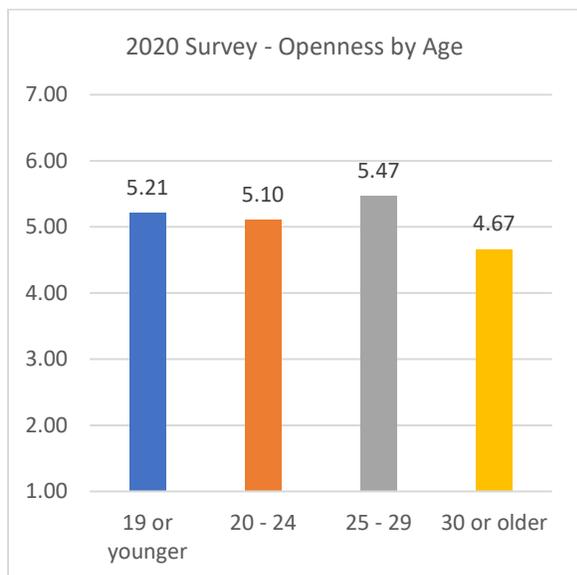
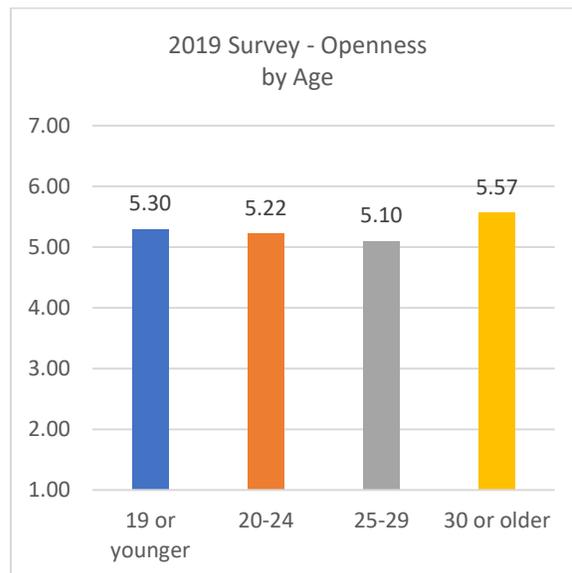
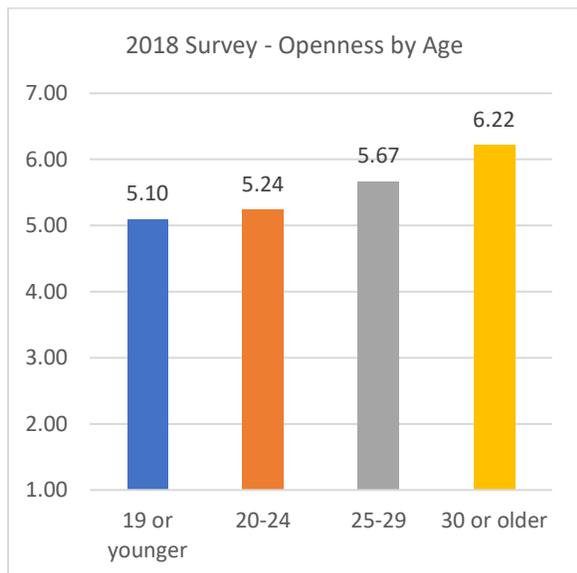


Transfer Status

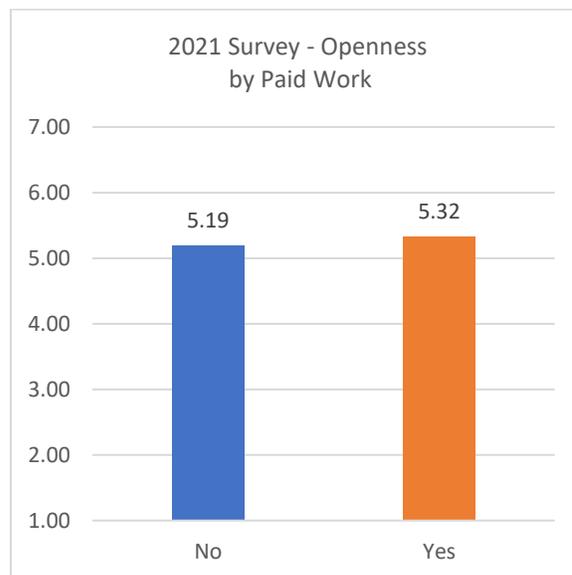
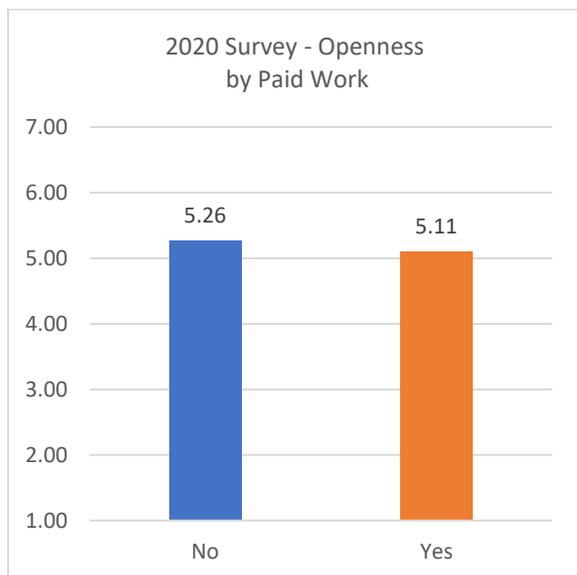
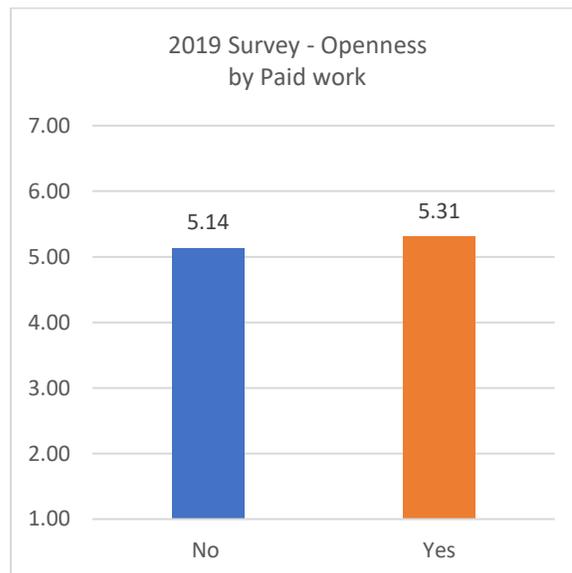
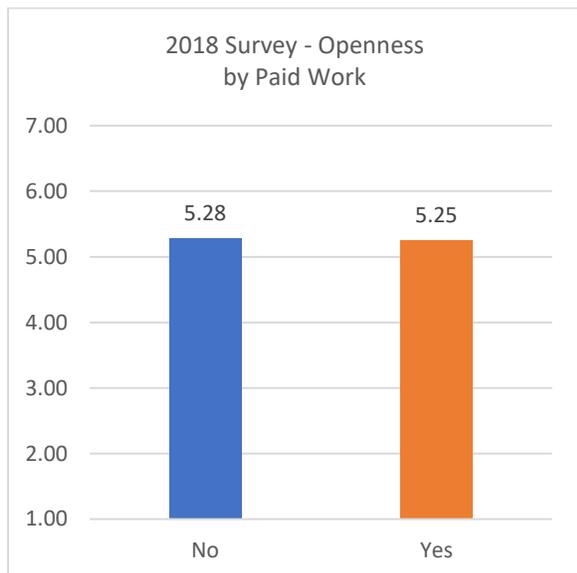


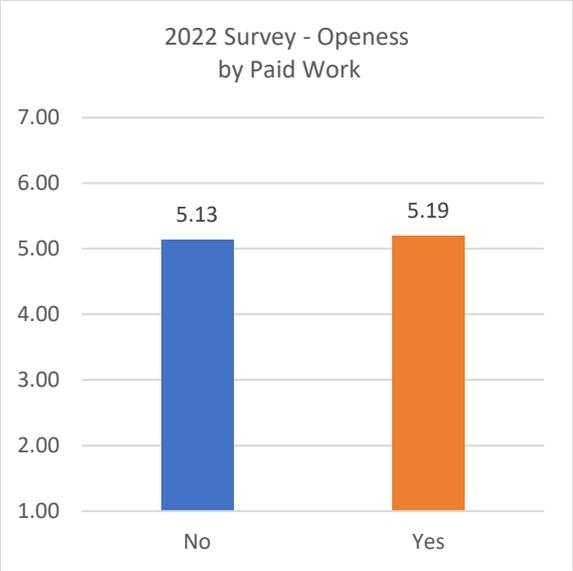


Age



Employment status





Grit (Consistency of interest)

Grit is defined as perseverance and passion for long-term goals and can be viewed as an essential component to high achievement beyond personality and intelligence. This dimension captures an individual's intensity, direction, and duration towards achieving a goal [18]. Early research on grit showed that grit was a better predictor of success than other measures of preparation including I.Q. or talent [19]. The original proposer of grit, Angela Duckworth, also claims that anyone can learn to be "gritty" [17].

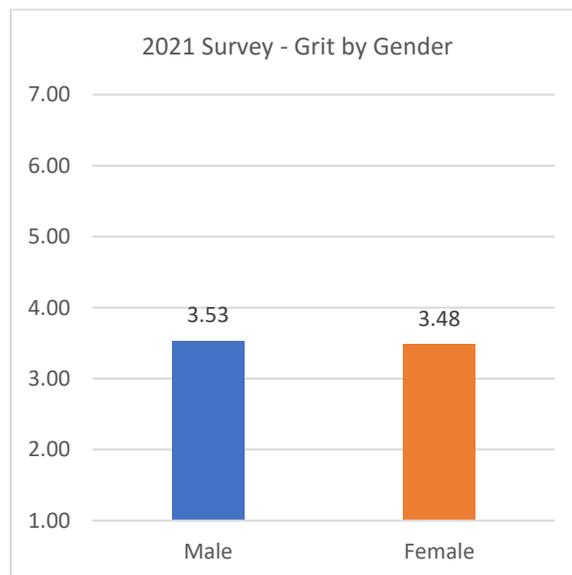
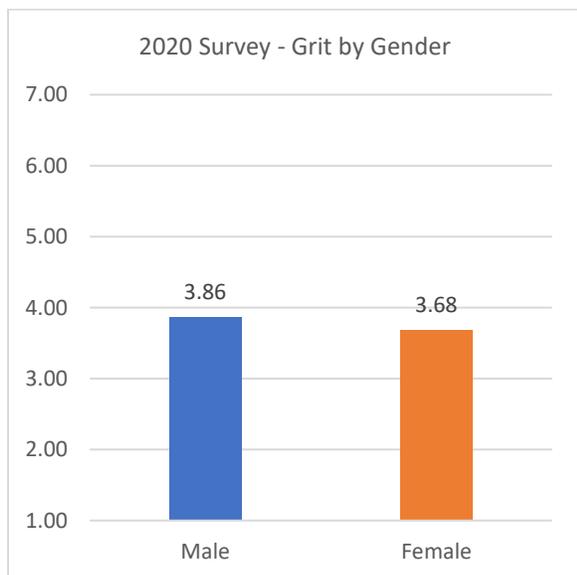
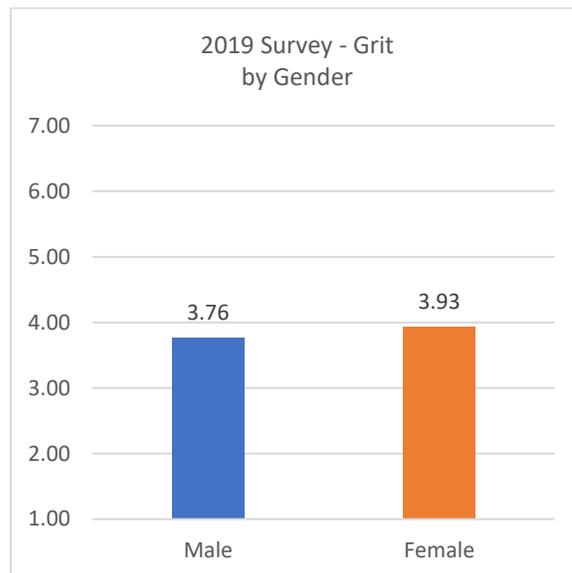
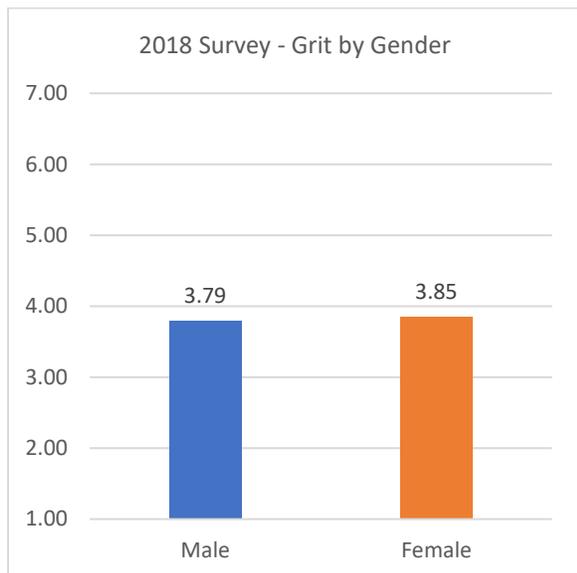
We acknowledge that there has been some concern about the use of grit as a privileged measure of students' abilities to focus solely on one goal regardless of their background or circumstances [82, 96]. Additionally, a recent meta-analysis of grit studies showed that the construct might be only weakly correlated with student success. However, the authors of the meta-analysis do point out that the perseverance of effort may be the more useful dimension on which to focus [13].

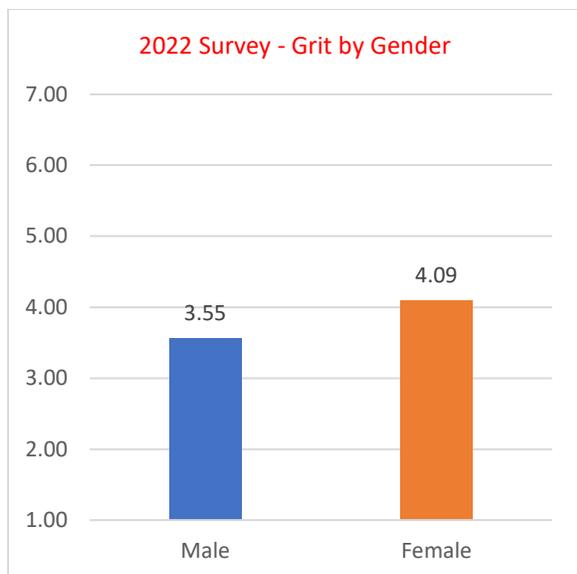
Number of items: 4

Interpretation of the Scale: Higher grit scores indicate that students are more likely to stay focused

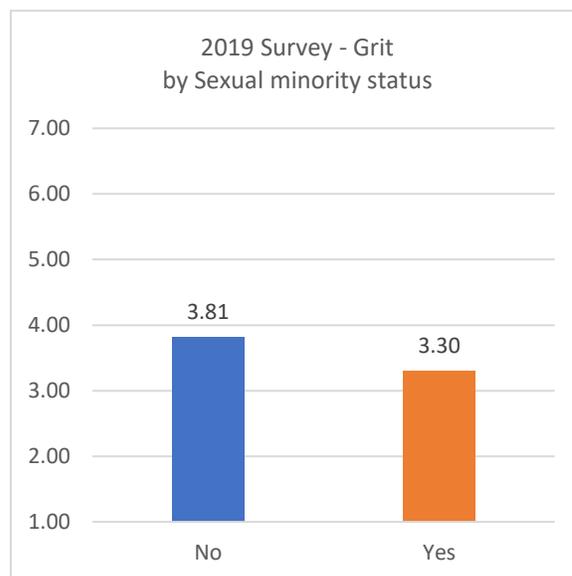
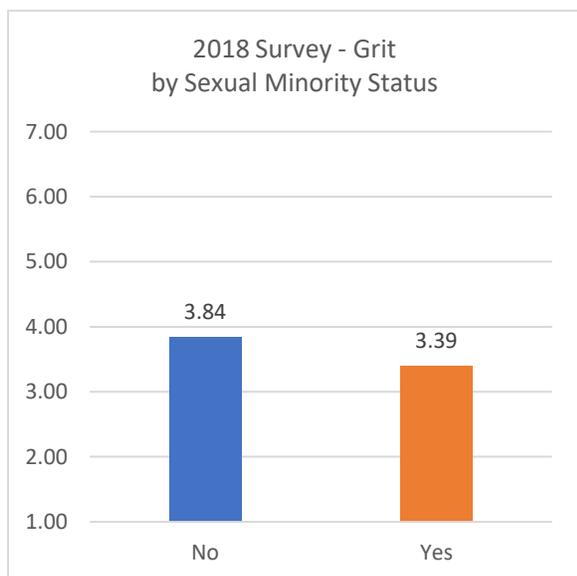
Malleability: Recent research has shown that grit may be malleable and interventions can be designed to promote deliberate practice [17, 25]. These interventions focus on asking students to set a specific stretch goal, fully concentrate on a single task, receive immediate and informative feedback, and practice repetitively until fluent [23]. While these interventions show promise, there is not yet enough information to show that particular interventions produce specific results, especially with engineering and computing students.

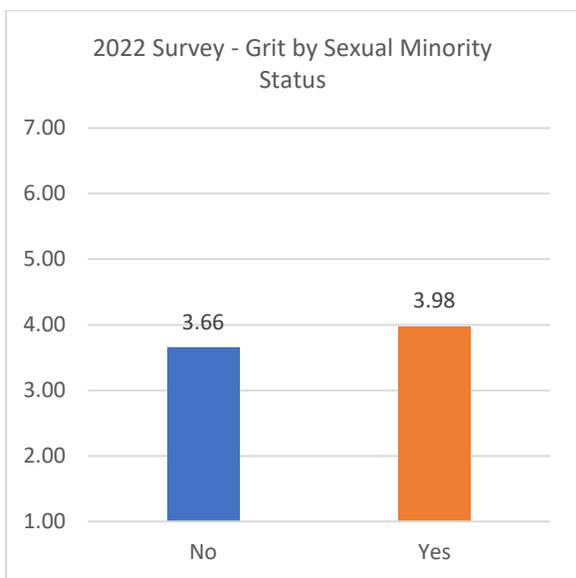
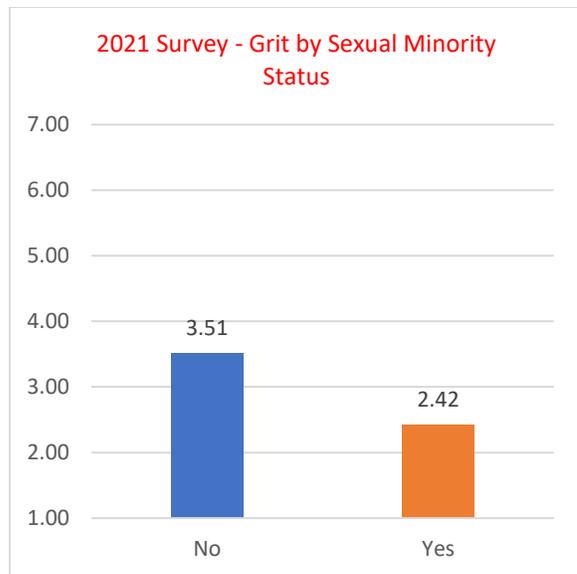
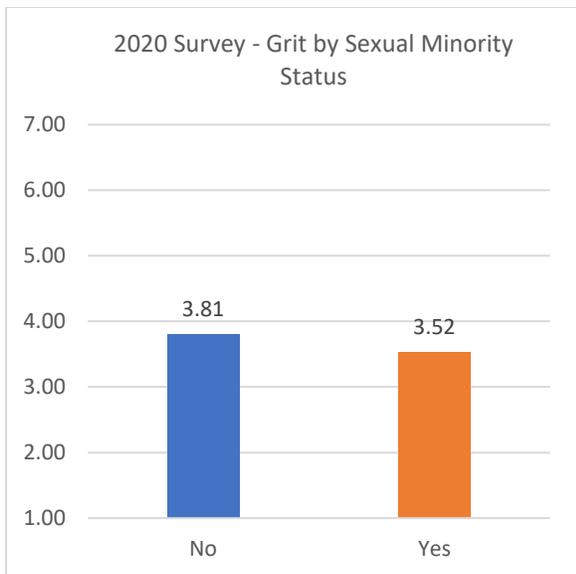
There is also a concern about some students who may be too gritty." In some studies, grittier participants were less willing to give up on a failing endeavor, even though they incurred costs for their persistence. For example, grittier students taking a test may persist at trying to solve an unsolvable (in the design of the research) problem rather than complete the other questions that were easier in an allotted amount of time [57]. This outcome may have implications for test-taking and other scenarios relevant to student success. We acknowledge that more research is needed on this topic, but also recognize that grit, as one of many dimensions of personality, may be a valuable and teachable trait in students.

Gender

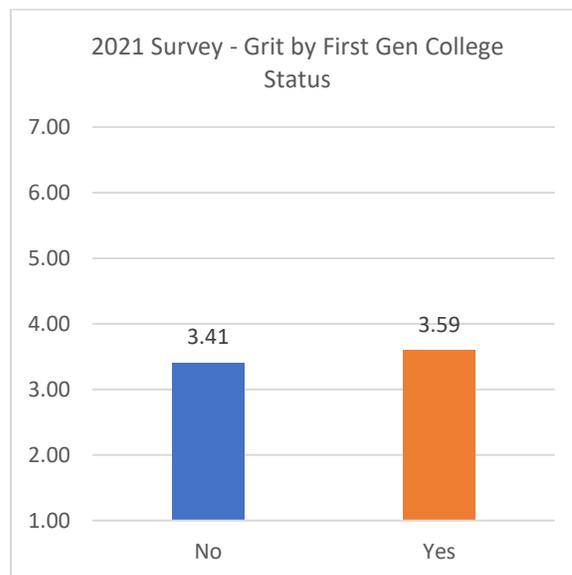
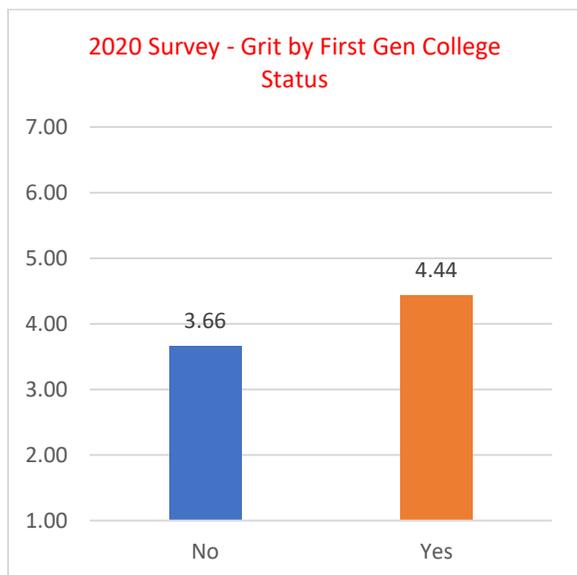
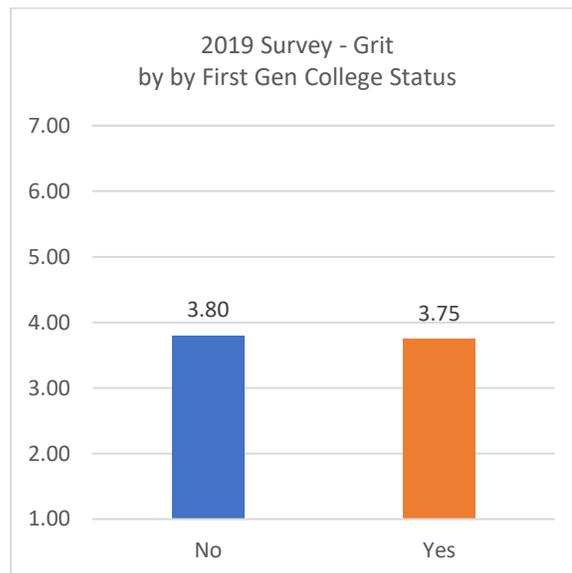
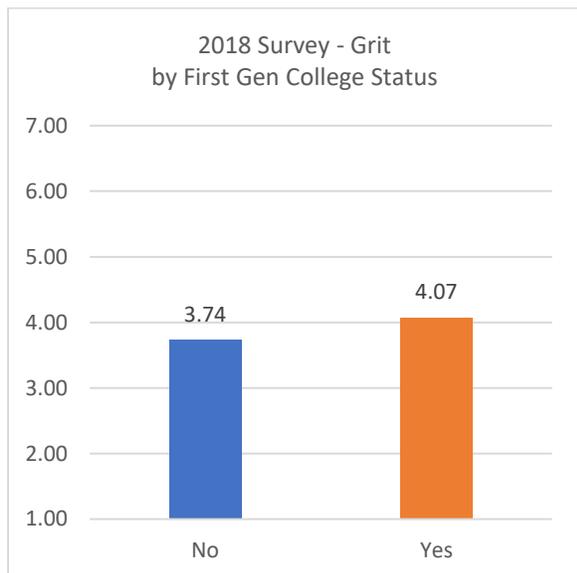


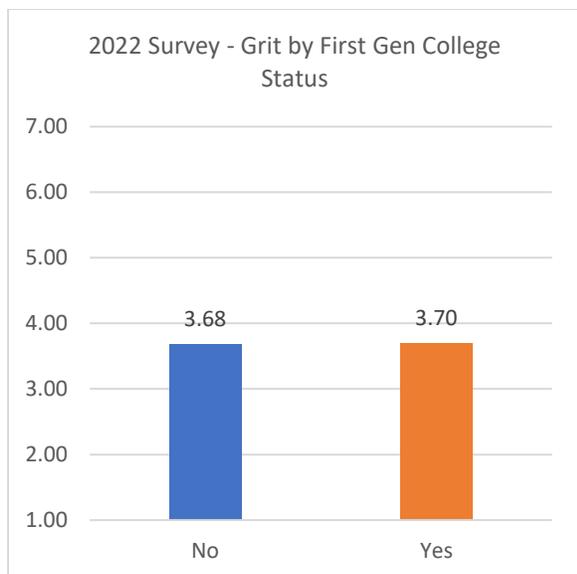
Sexual Minority Status



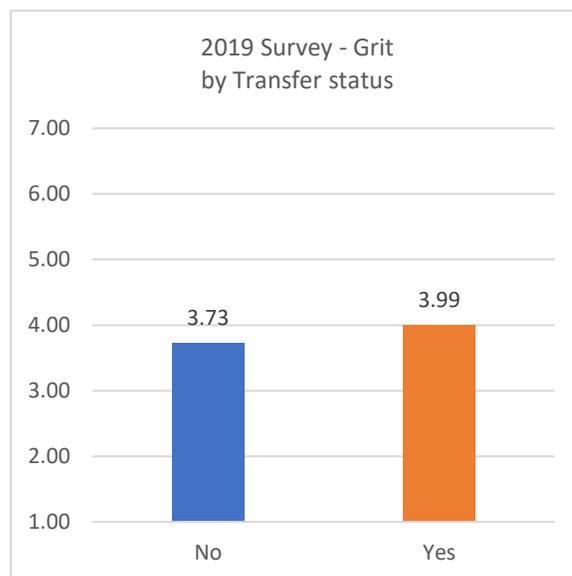
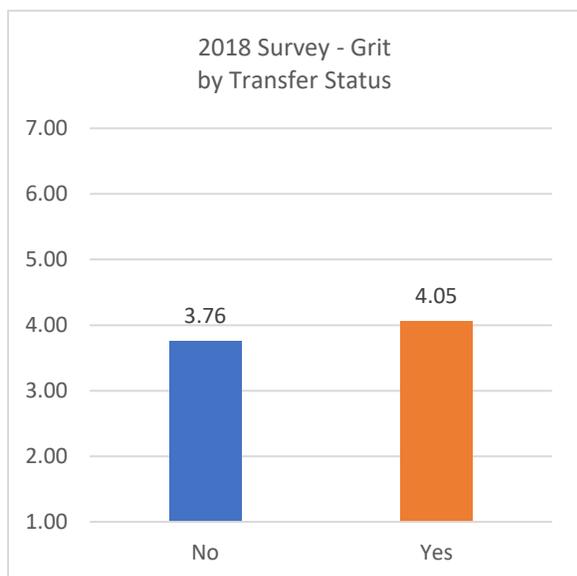


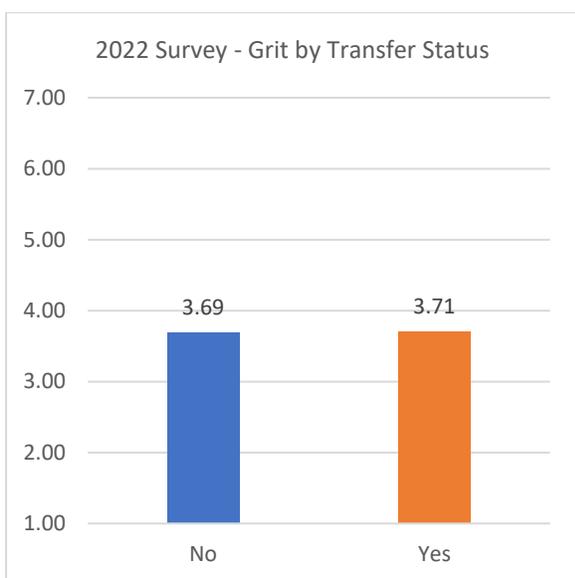
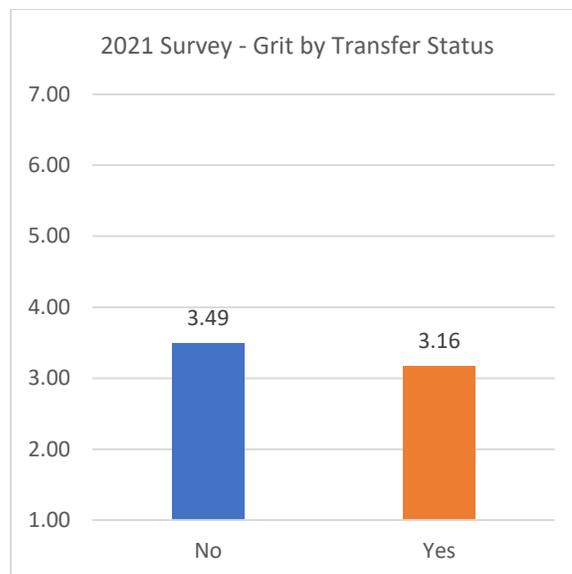
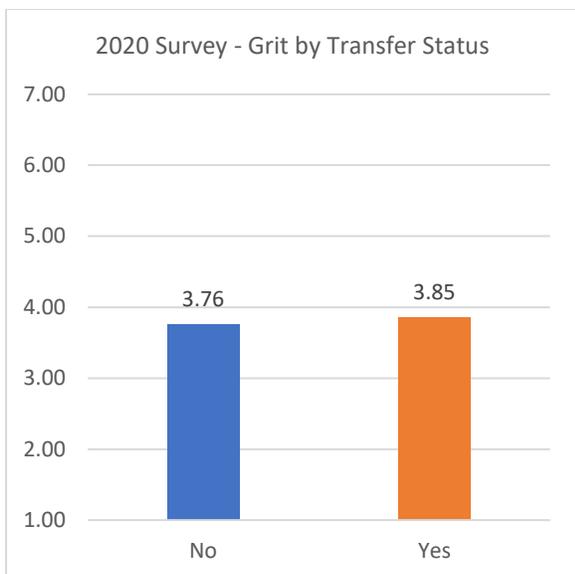
First-generation College Status



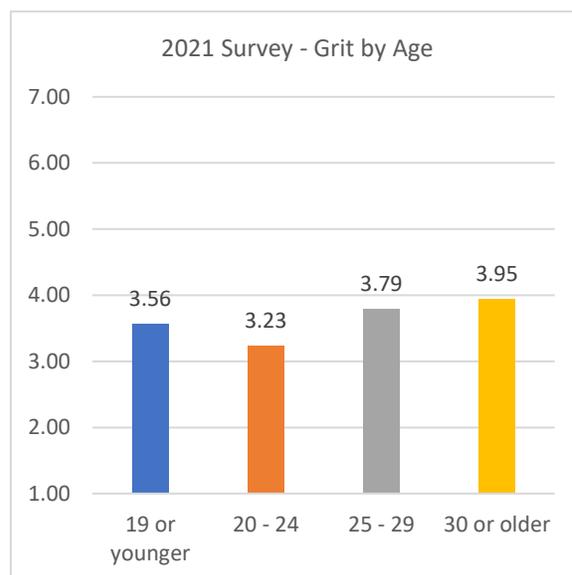
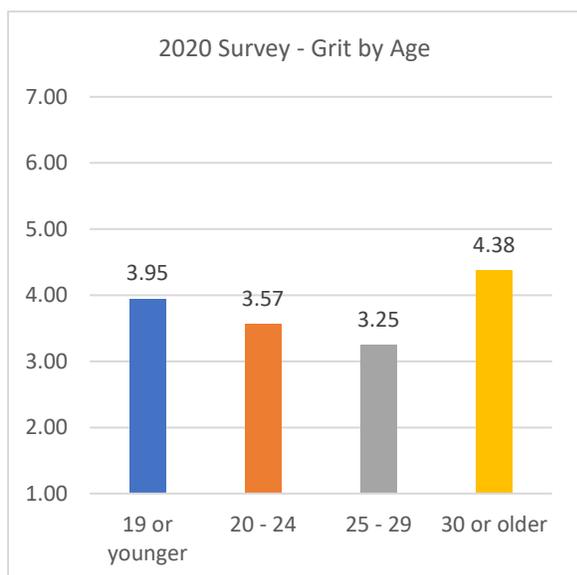
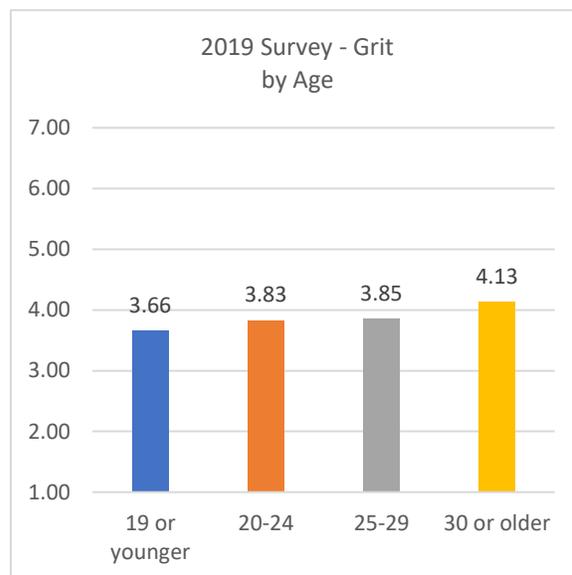
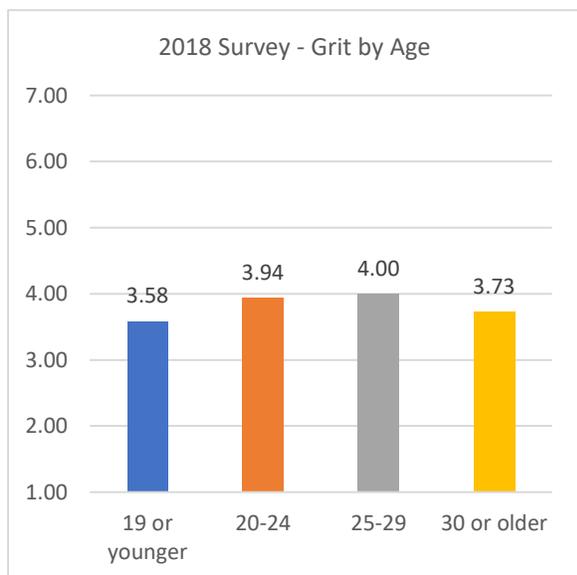


Transfer Status

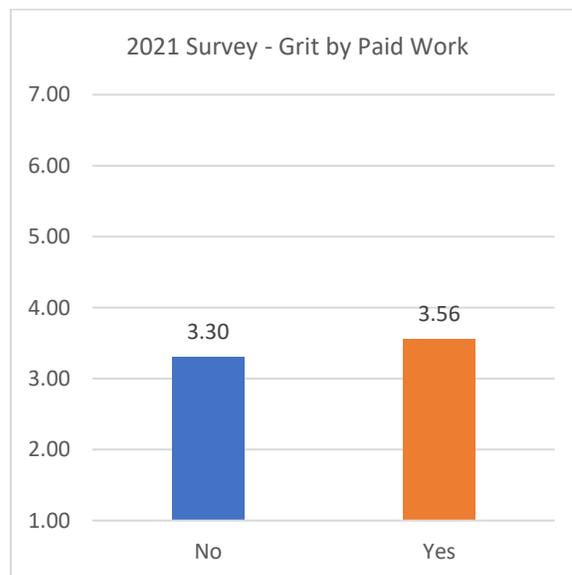
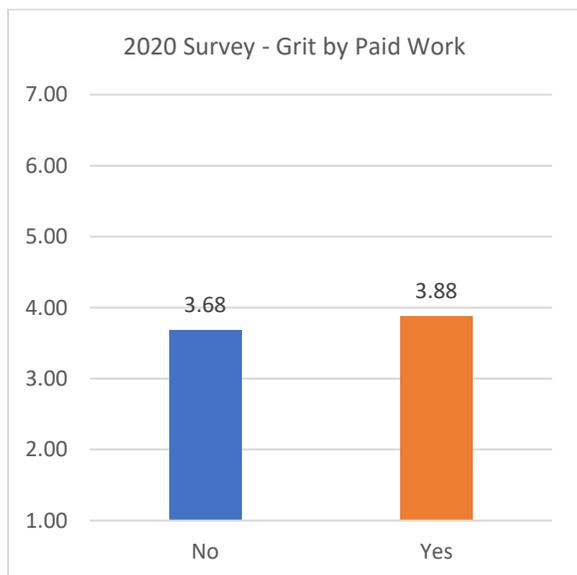
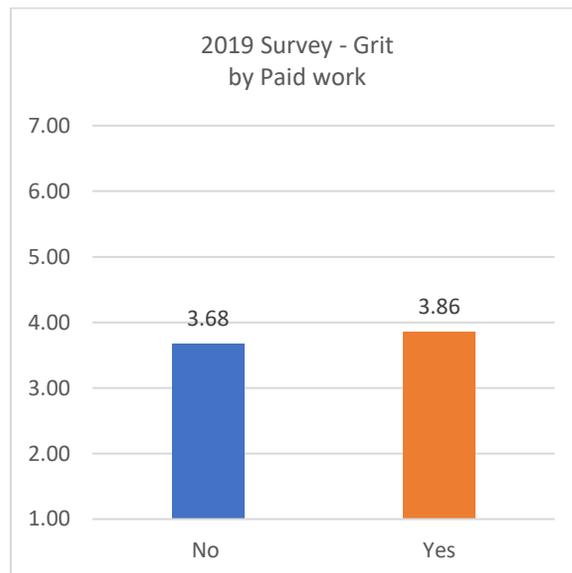
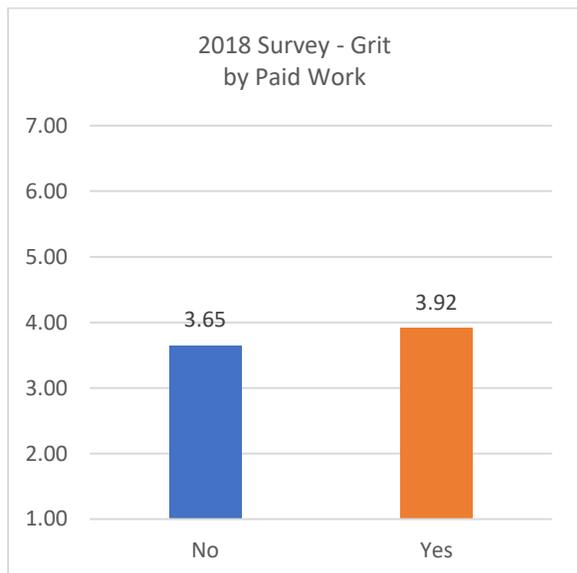


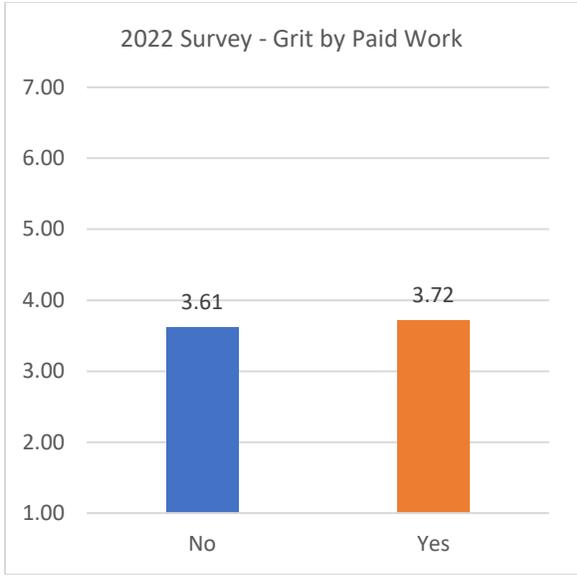


Age



Employment status





Engineering Identity

Identity is defined as being recognized as a certain 'kind of person,' in a given context" [35]. We emphasize that recognition is both from an individual as well as others, and that recognition develops as individuals tell stories about who they are and act in congruence with these stories [48]. Students whose identities align with their classroom and disciplinary roles experience an improved sense of belongingness, increased persistence, and better retention [39, 49, 53, 74, 76, 99]. We measured students' engineering identities in two dimensions: interest (their enjoyment of and desire to learn the subject) and recognition (their feelings that others see them as the kind of person who can succeed in an endeavor) [37].

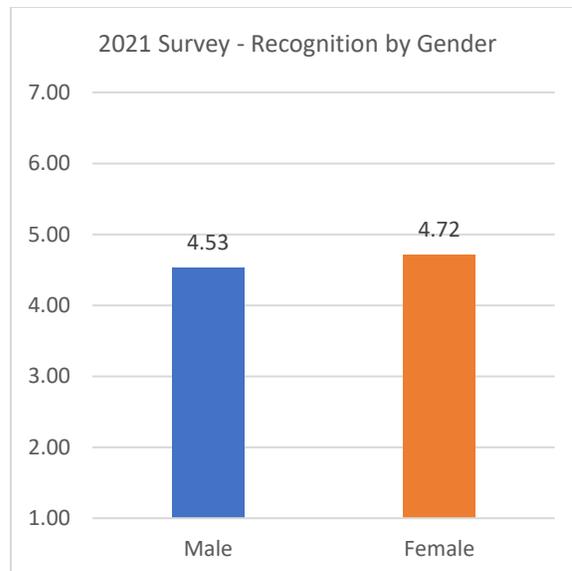
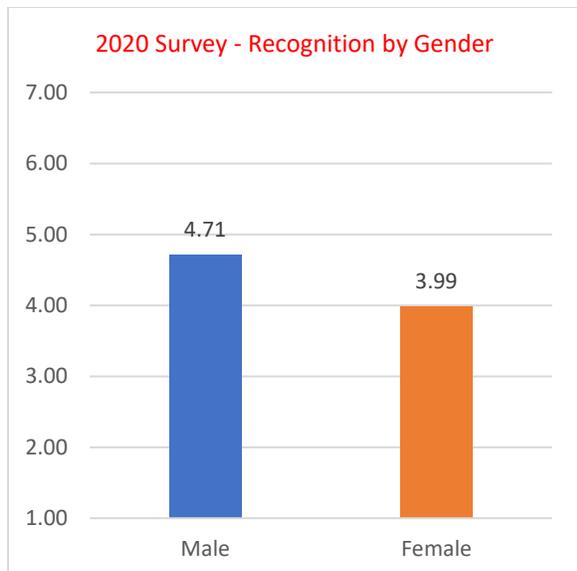
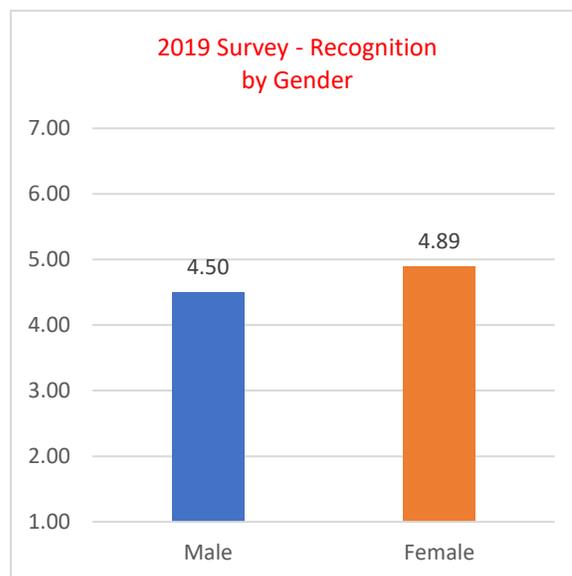
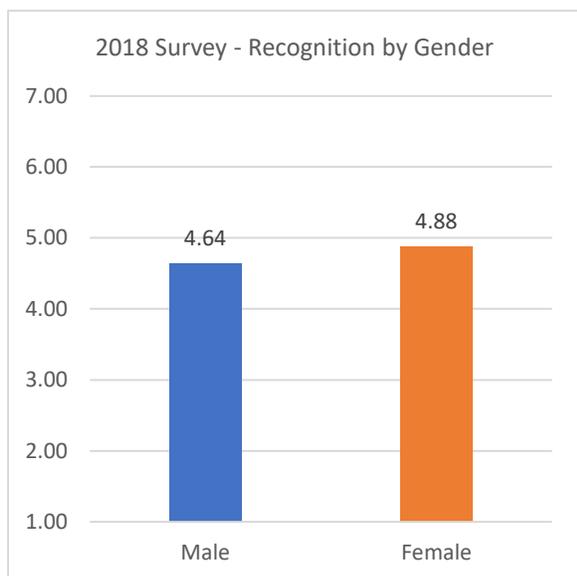
Number of items: 7

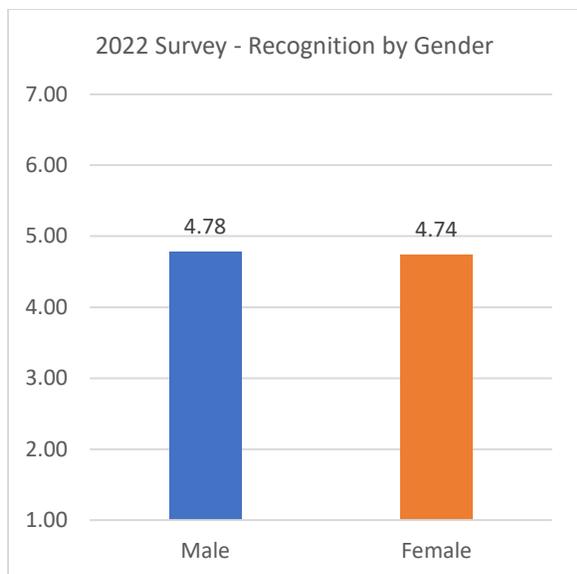
Interpretation of the scale: Higher scores indicate that students have a greater sense of identity in their engineering or computing major

Malleability: Identity is developed and changes over time. Particular identities are more salient within different contexts for engineering students [38]. Identity development in an academic setting can be promoted by, for instance, referring to engineering or computing students as engineering and computing professionals, rather than 'in-training' or future professionals, in the classroom. This subtle change in students' role can shape how they view themselves and may provide opportunities for recognition [55]. Instructors can also create projects that align with student personal interests [34, 80], or use active learning strategies [26, 59]. Instructors can also provide positive reinforcement and educational opportunity to all students in the classroom including those who may be struggling by avoiding always calling on the same students or only recognizing the 'smart' students in the classroom. For instance, those who are deemed 'smart' (by measures of grades and test scores) often are afforded certain educational opportunities and pathways not afforded to those deemed 'struggling' (by the same measures) [45].

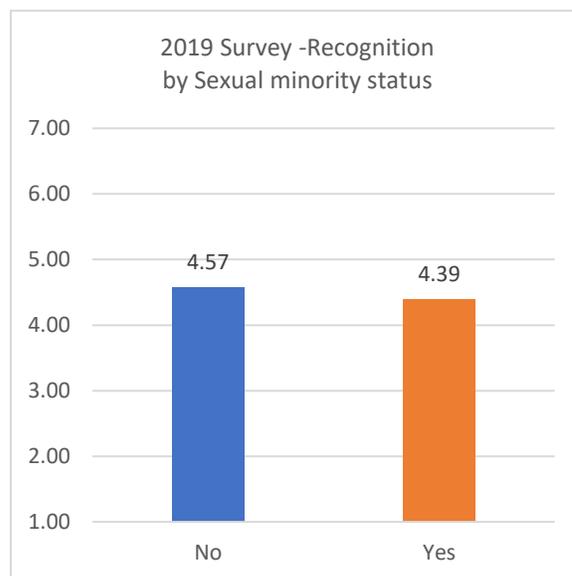
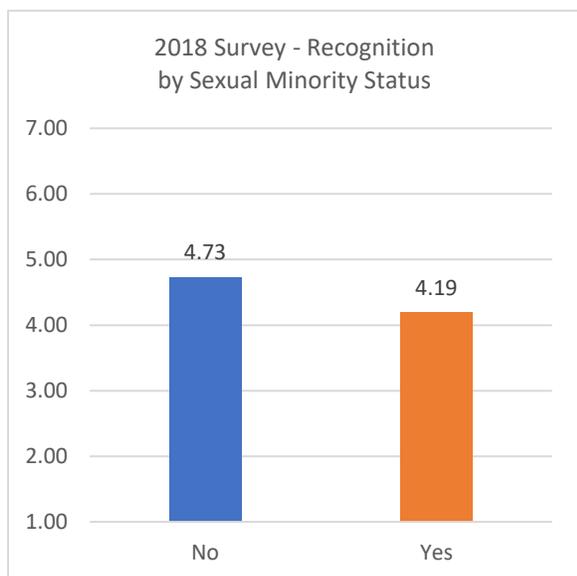
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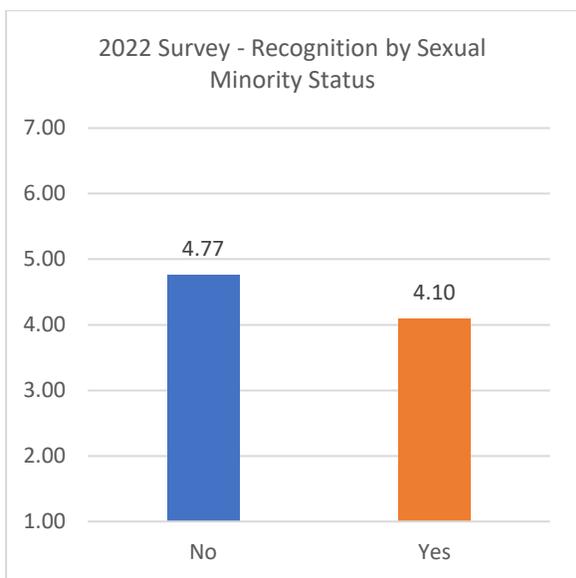
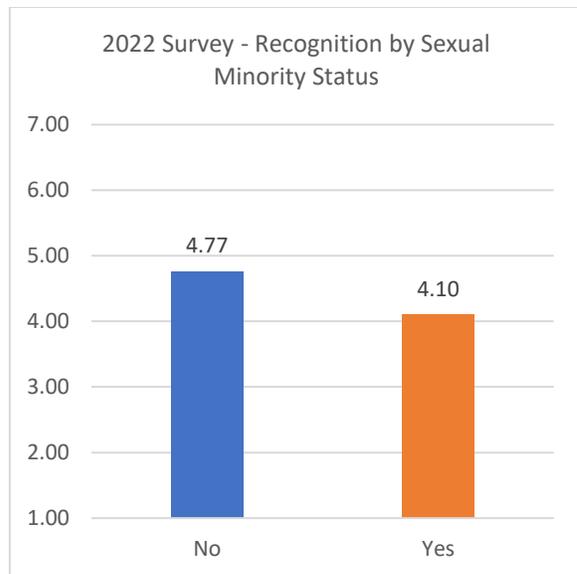
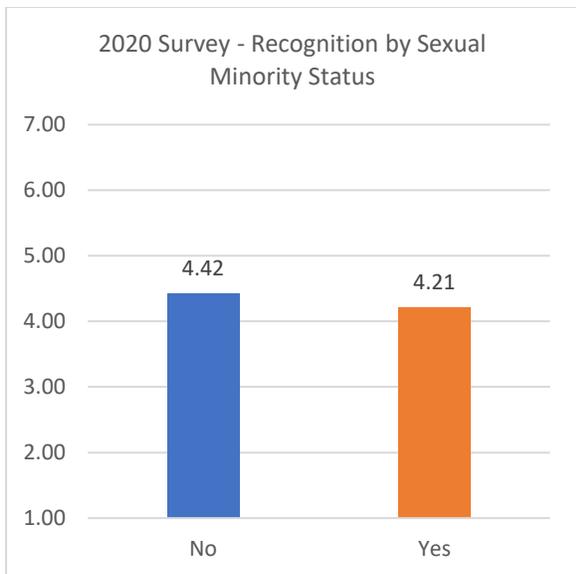
Gender



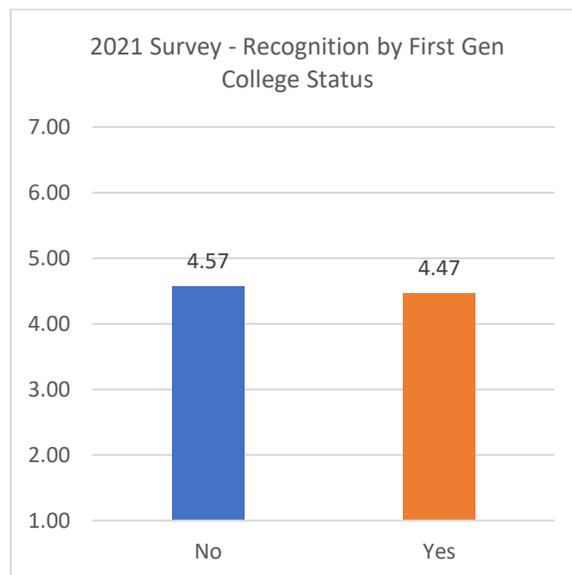
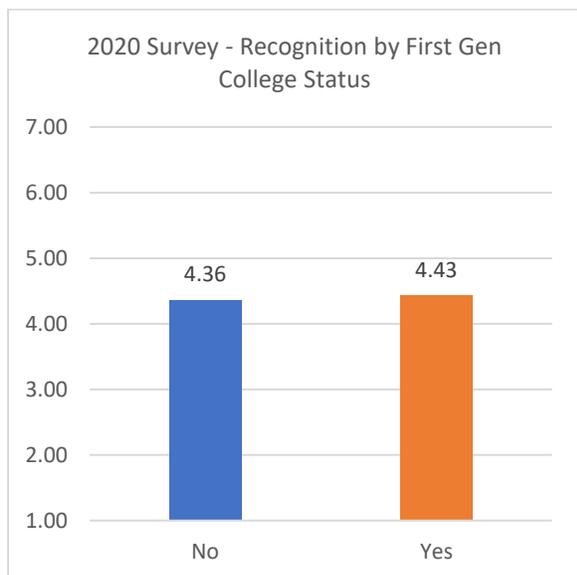
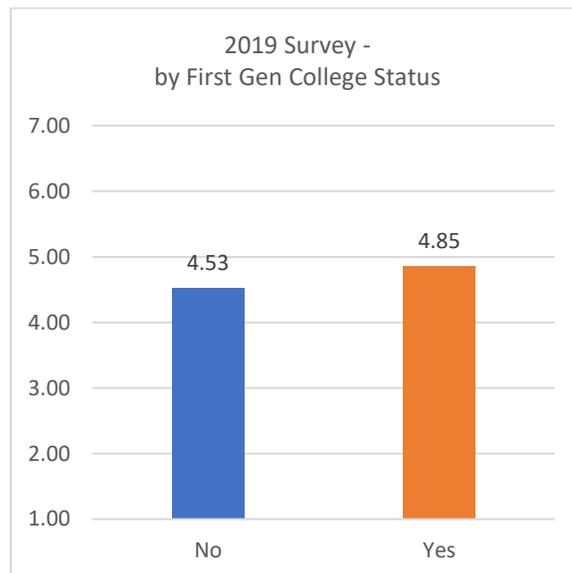
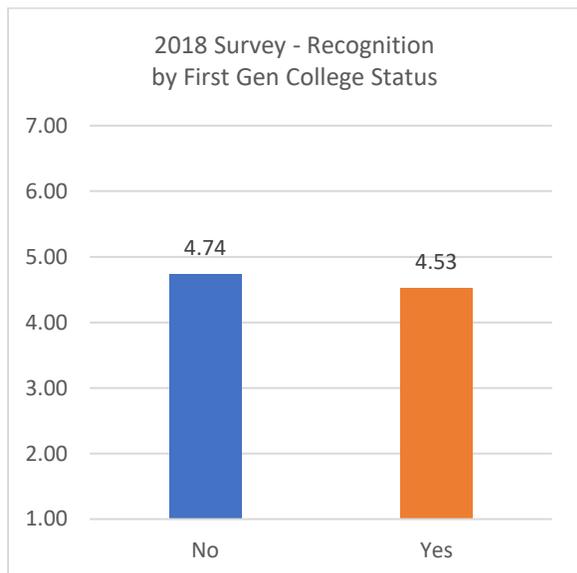


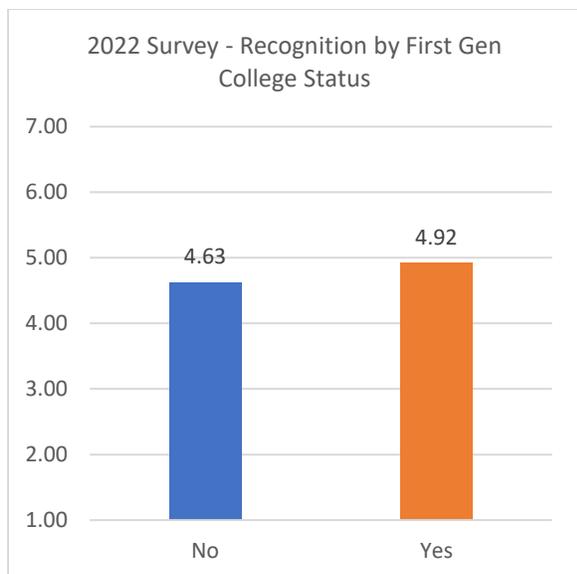
Sexual Minority Status



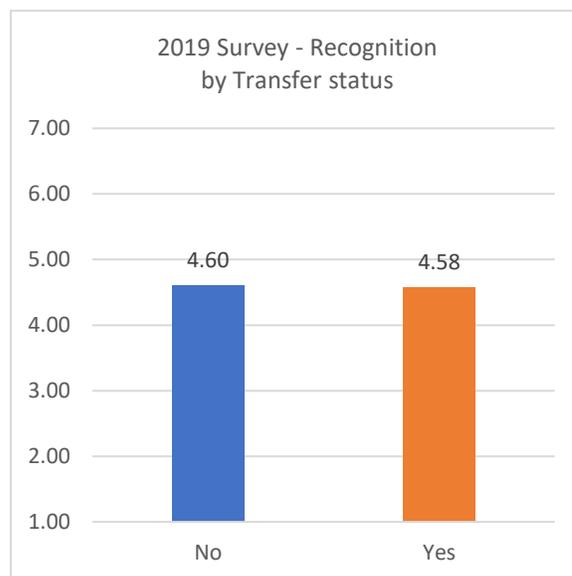
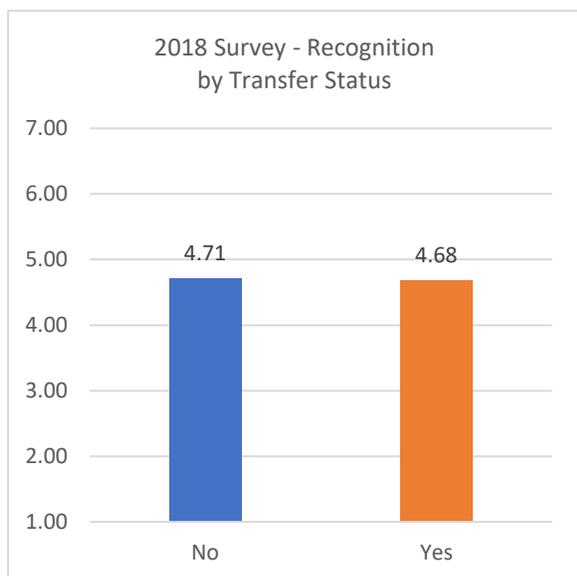


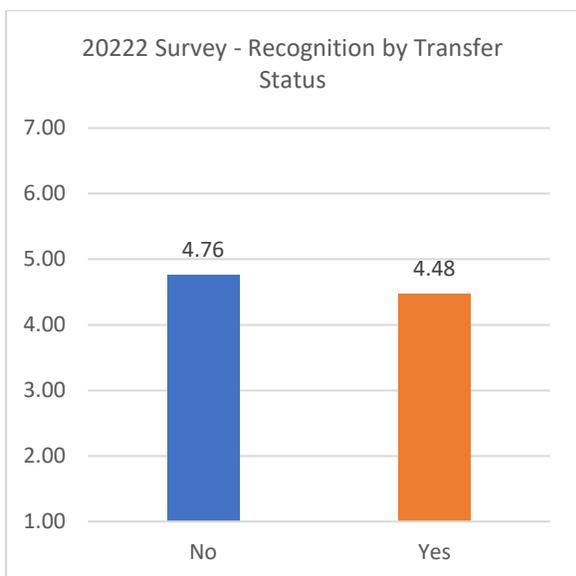
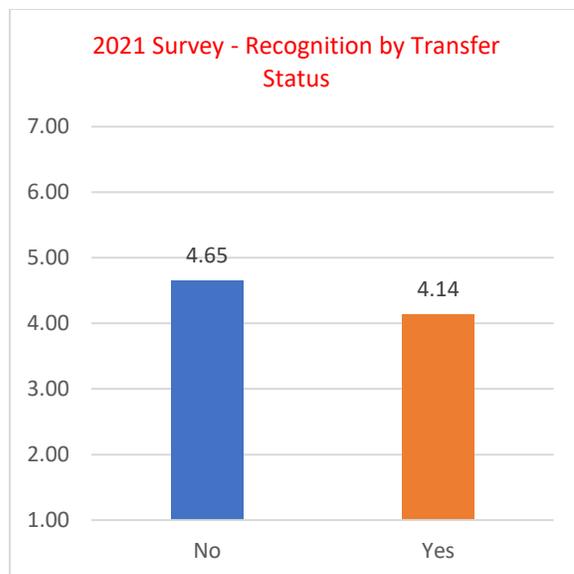
First-generation College Status



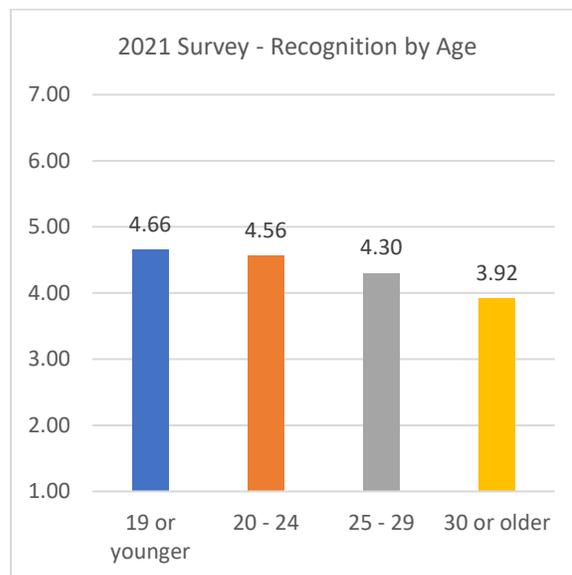
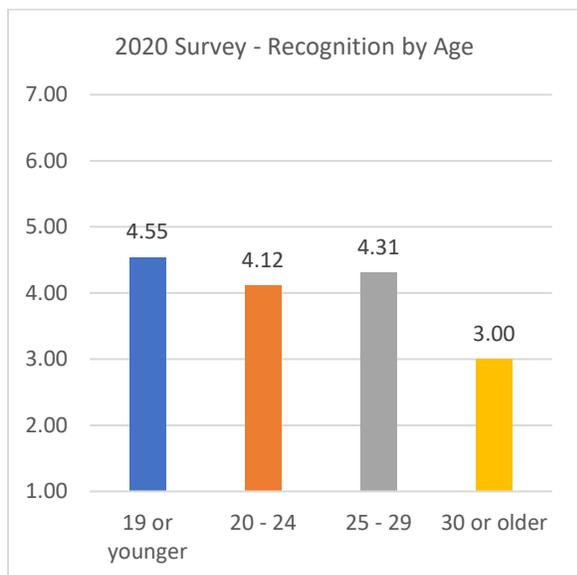
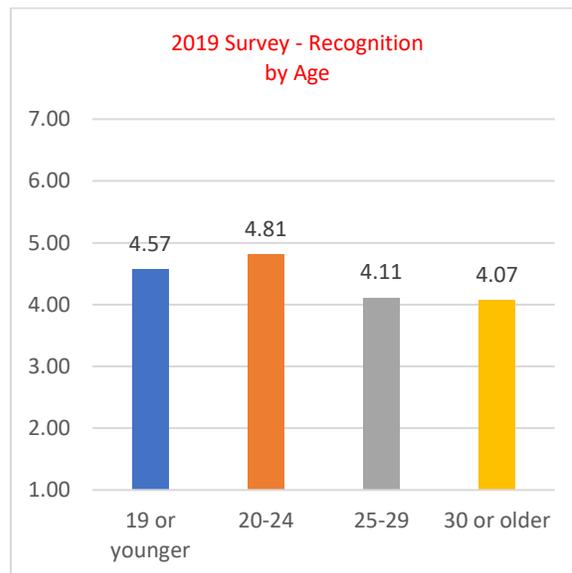
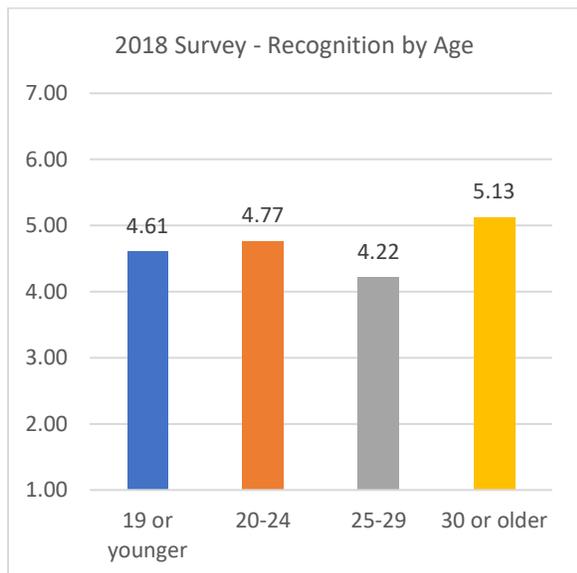


Transfer Status

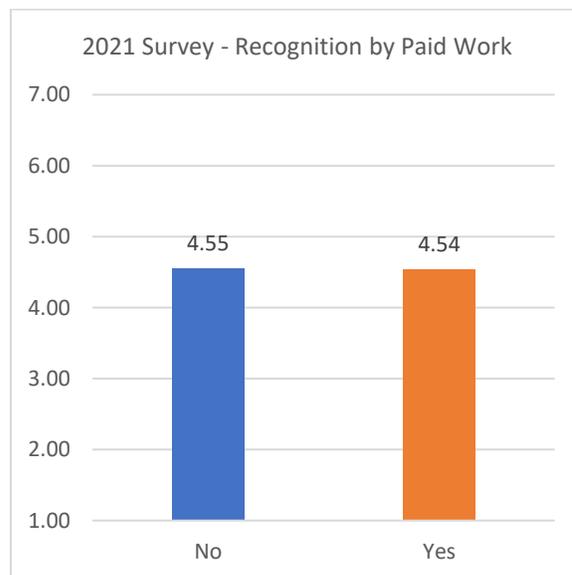
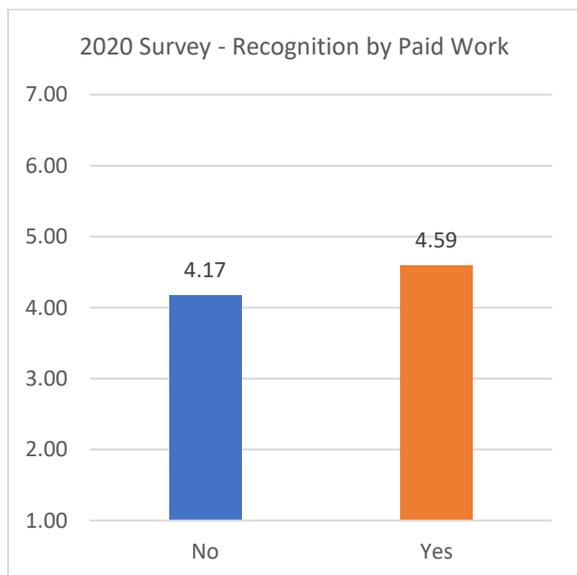
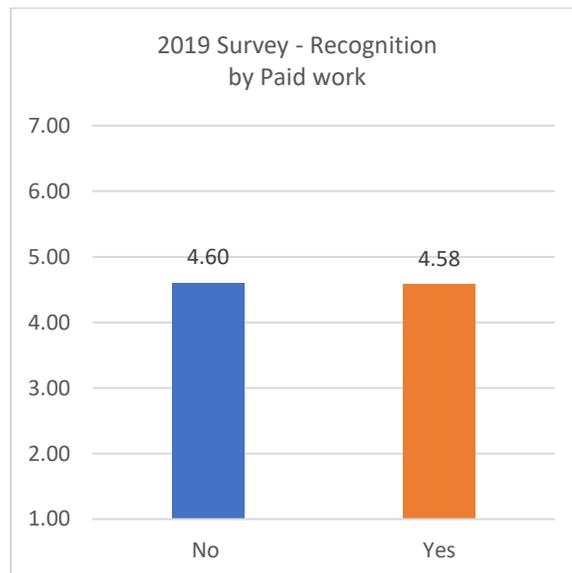
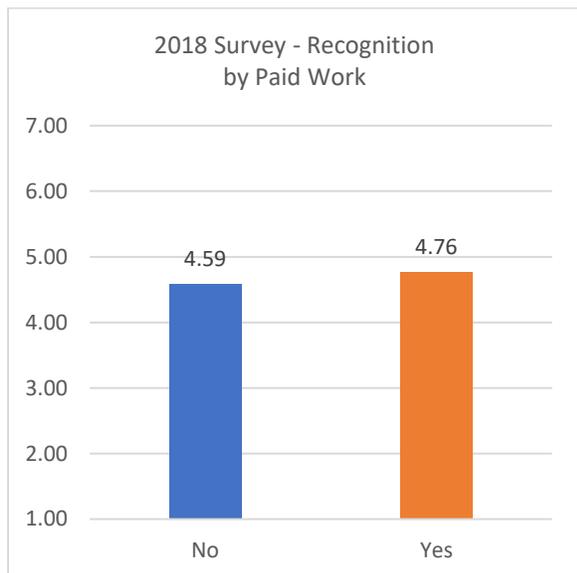


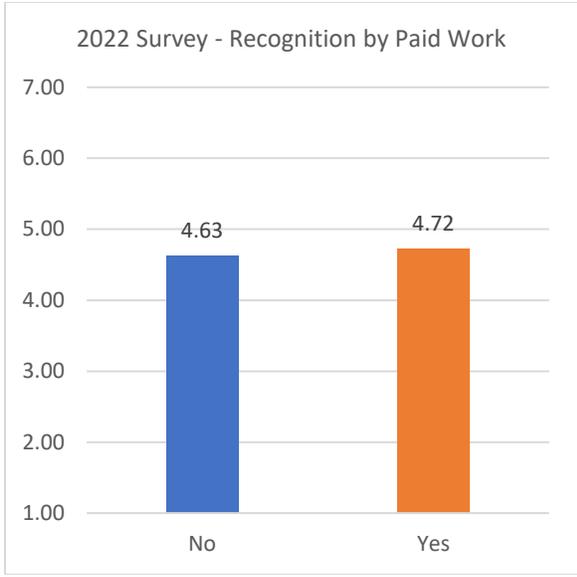


Age



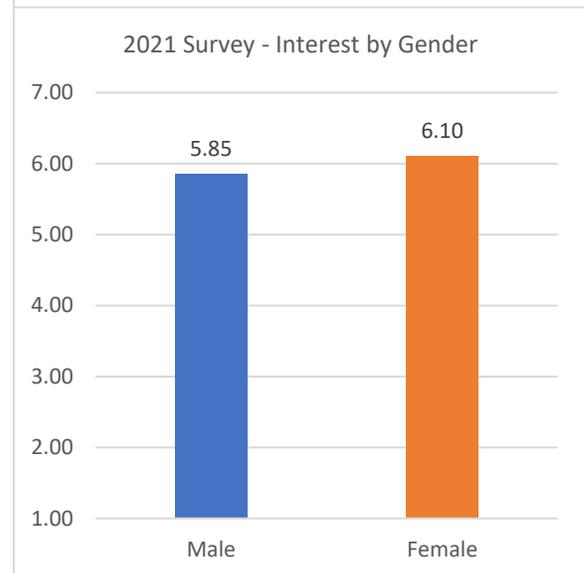
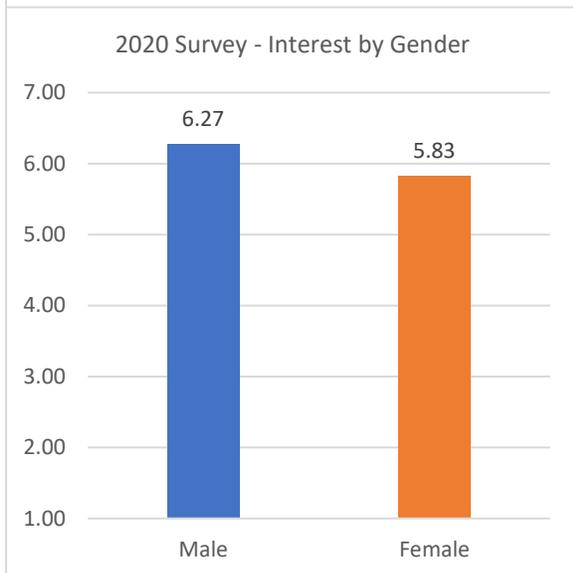
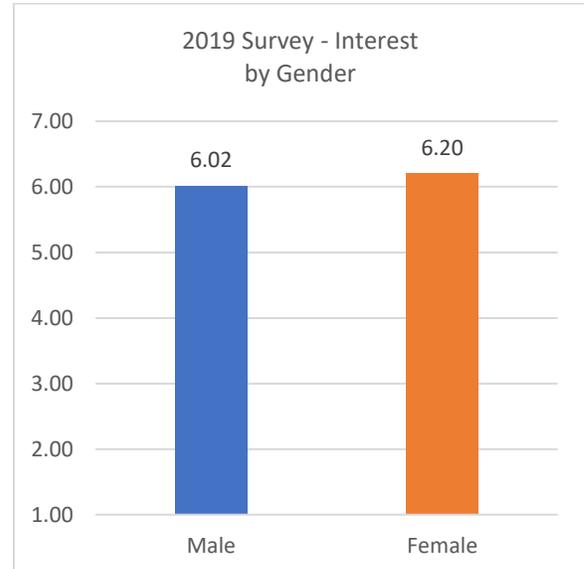
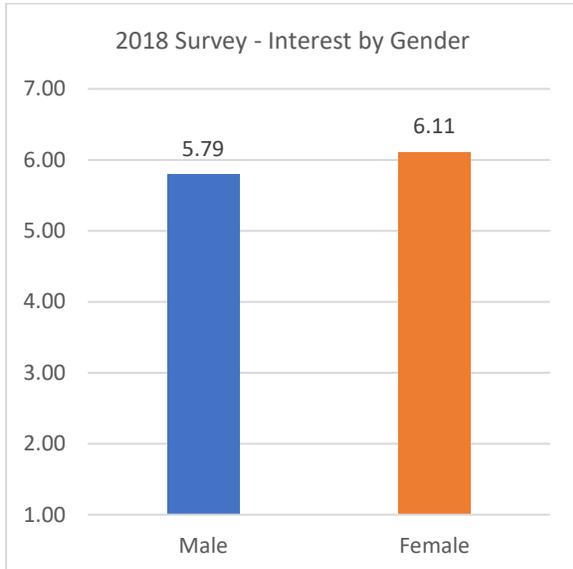
Employment status

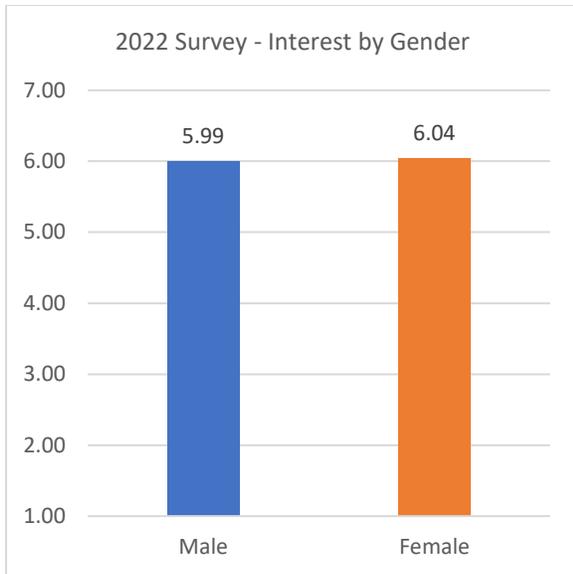




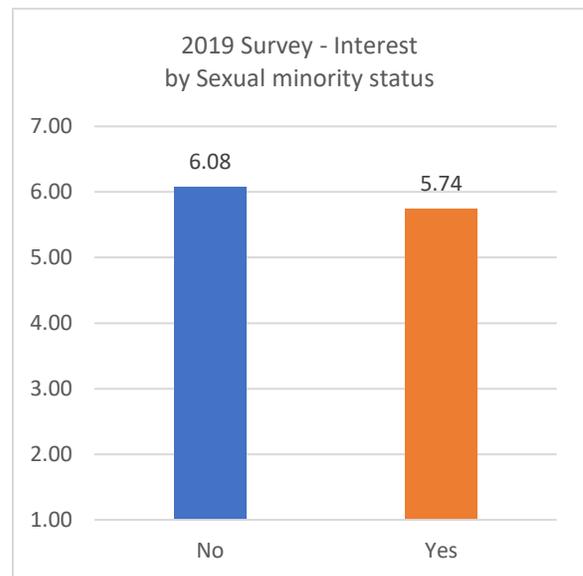
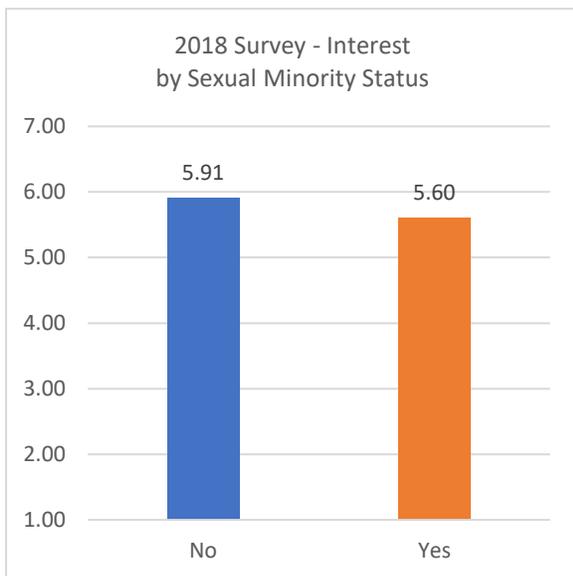
2) Interest

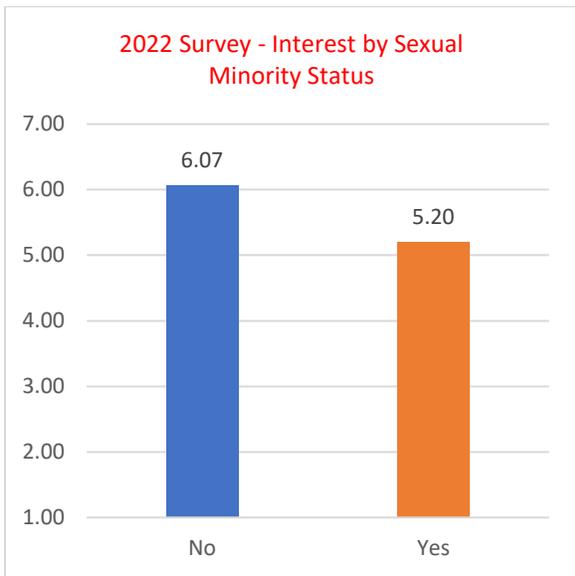
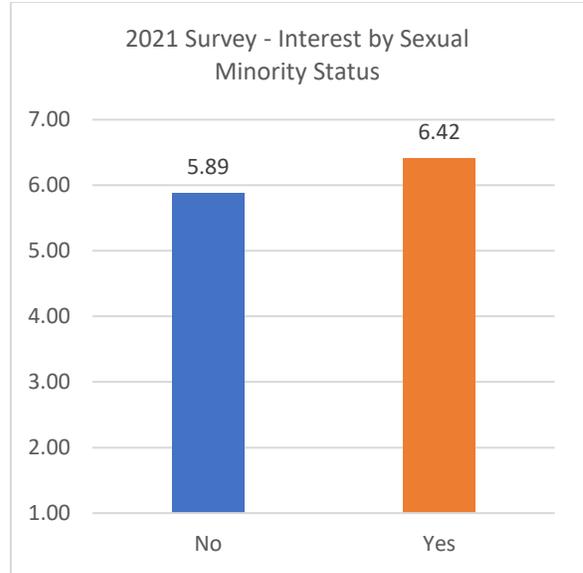
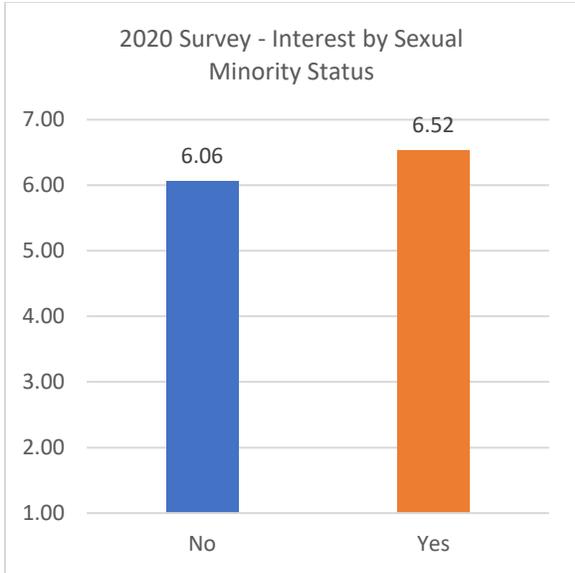
Gender



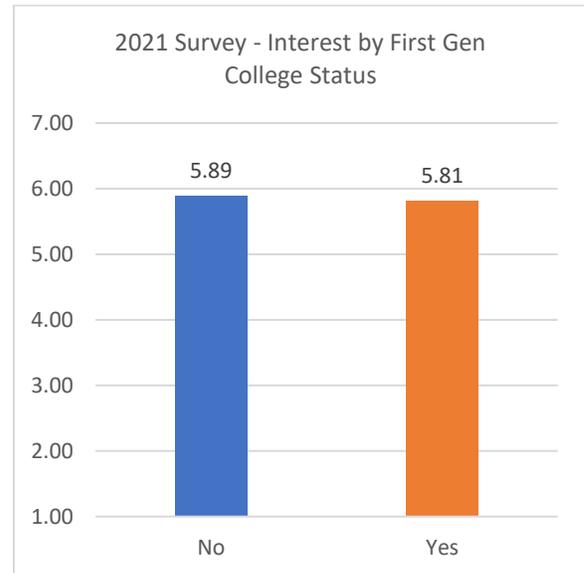
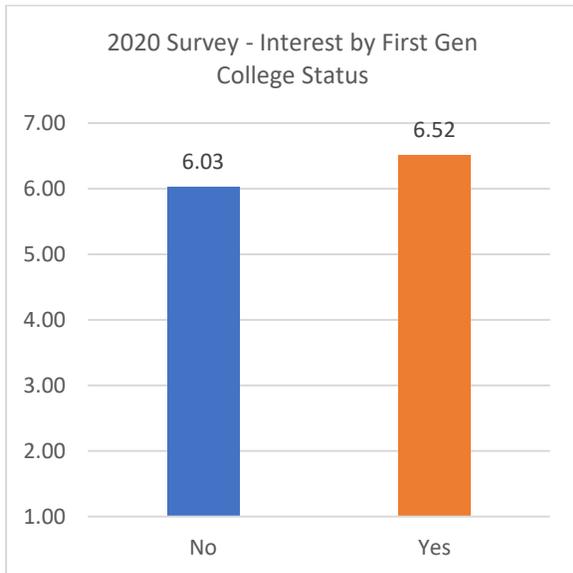
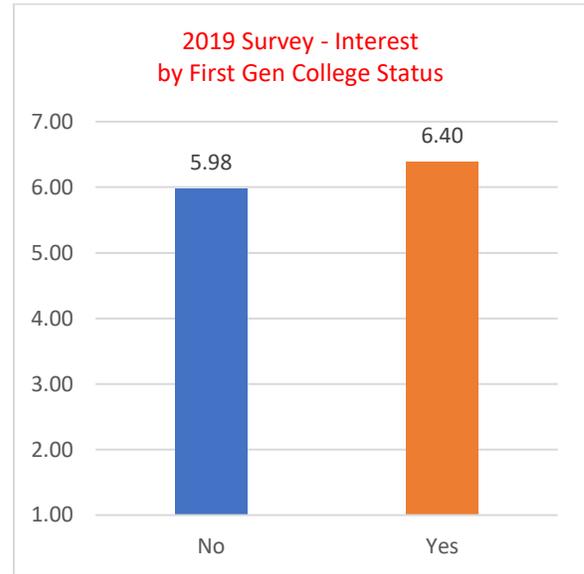
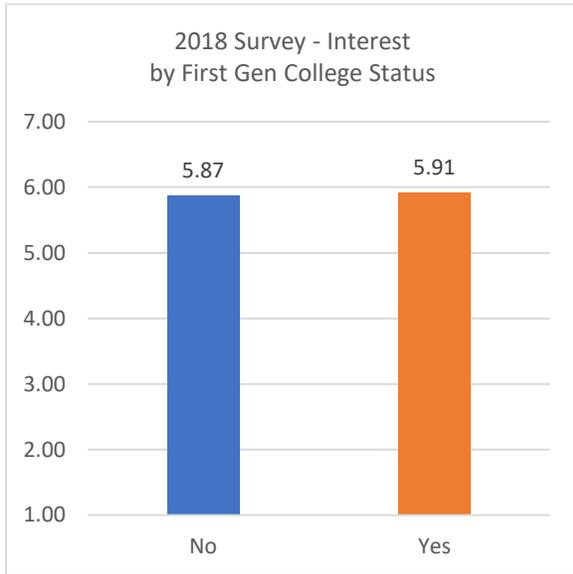


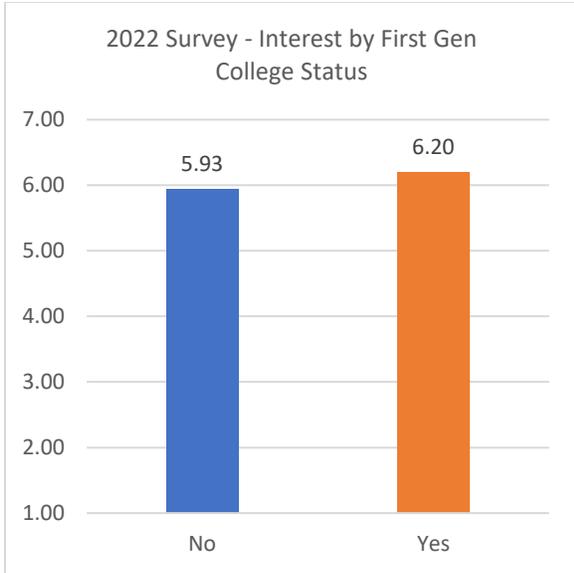
Sexual Minority Status



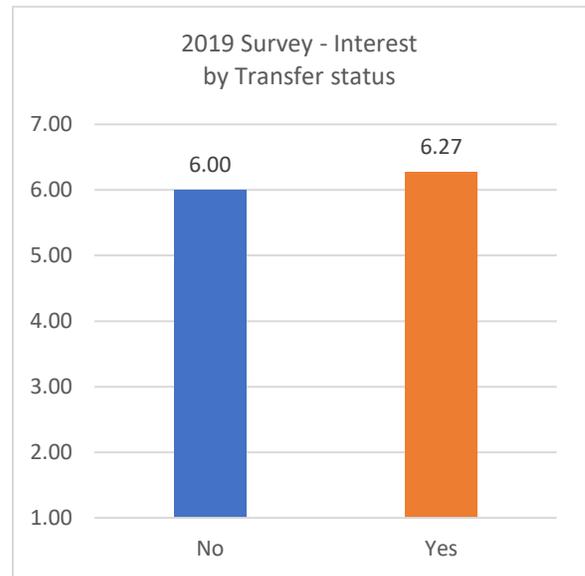
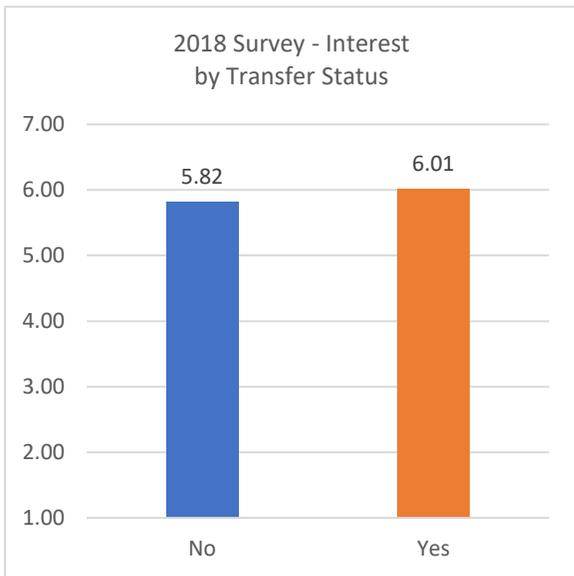


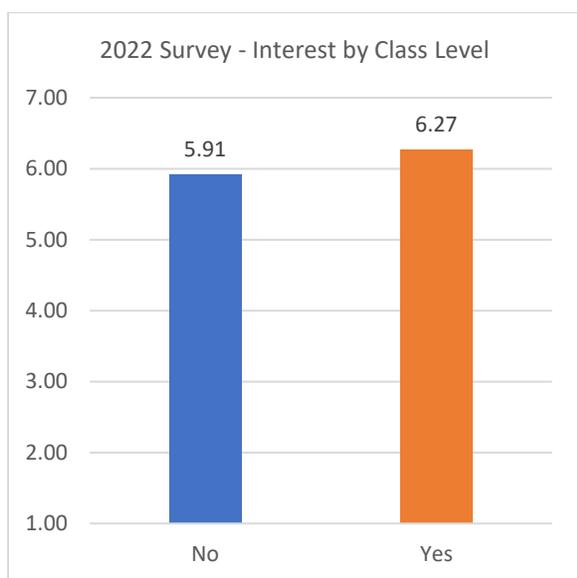
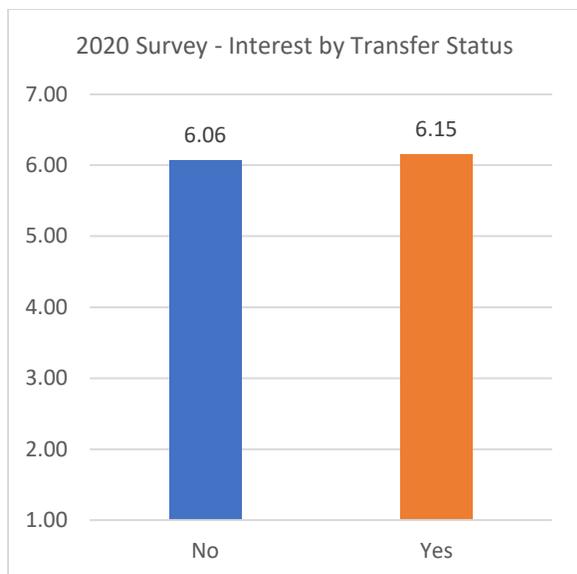
First-generation College Status



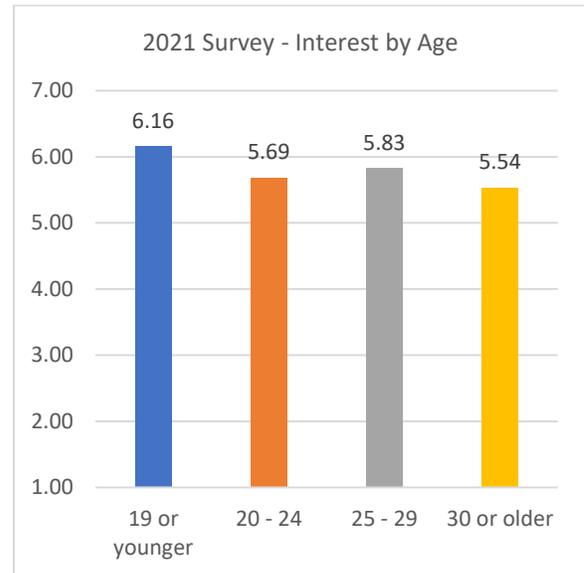
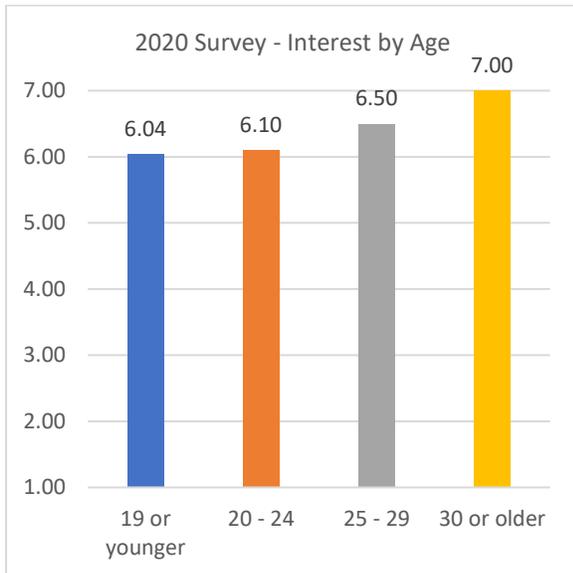
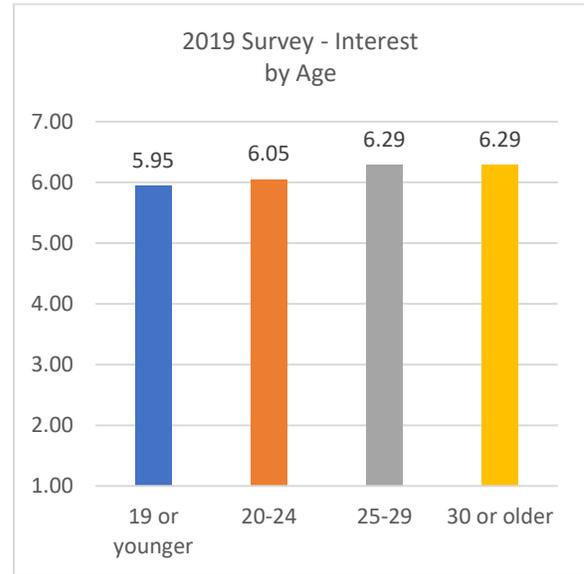
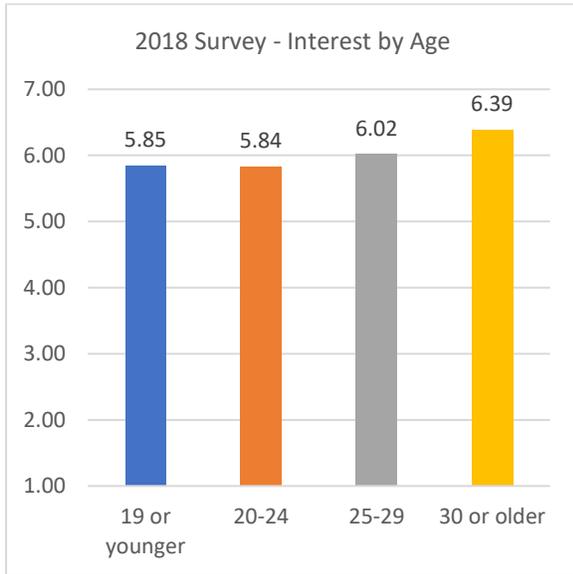


Transfer Status

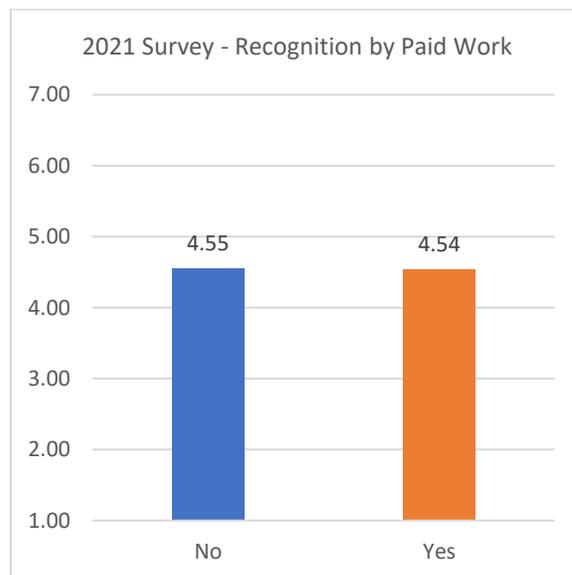
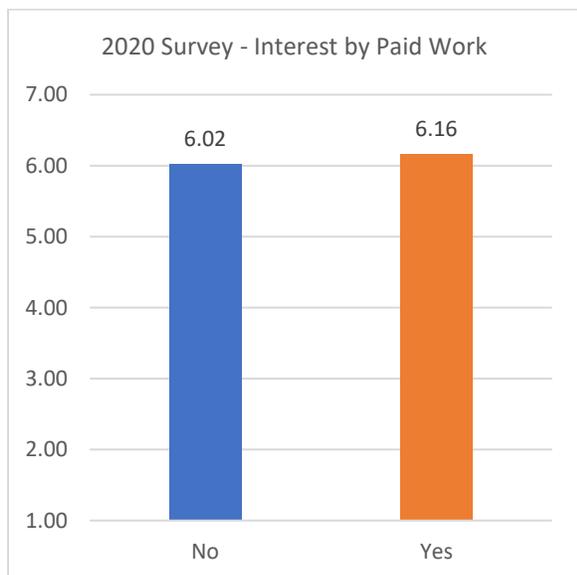
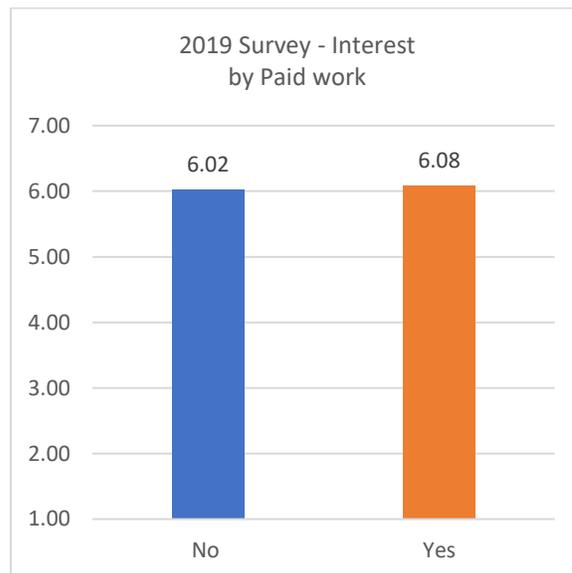
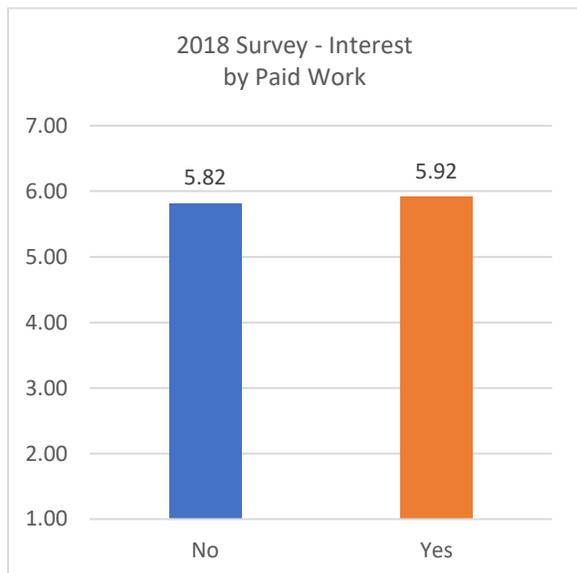


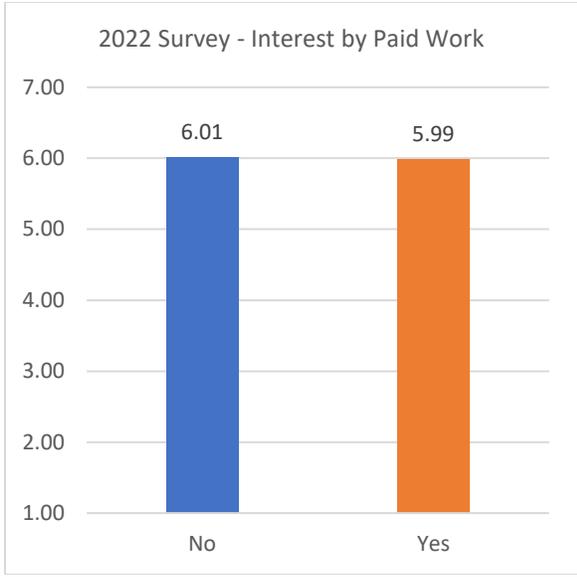


Age



Employment status





Mindset

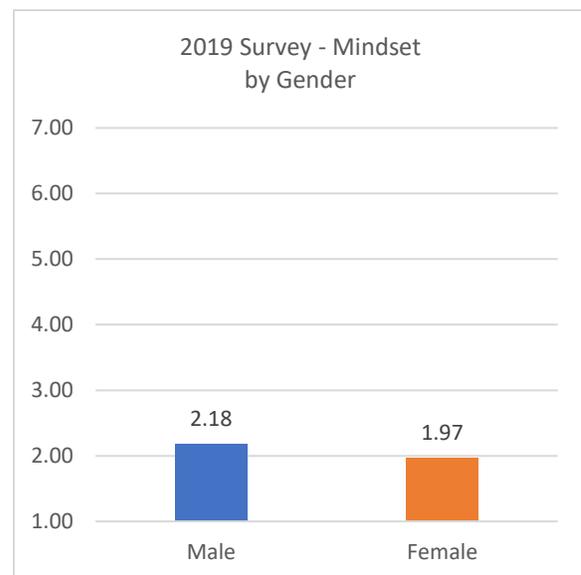
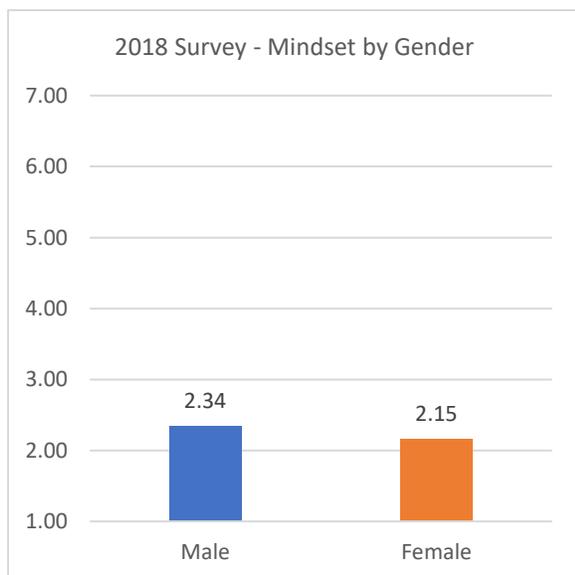
Mindset is a construct designed to gauge individuals' beliefs about their own talents and intelligence. We measured fixed mindset (talents and intelligence are set and cannot be changed). [21]. This factor is occasionally referred to as entity beliefs and incremental beliefs. To measure fixed mindset we used a six-item instrument. Each item presented a statement (e.g., "I don't think I personally can really change how intelligent I am") [16]. Mindset has been associated with student resilience and their subsequent success [100].

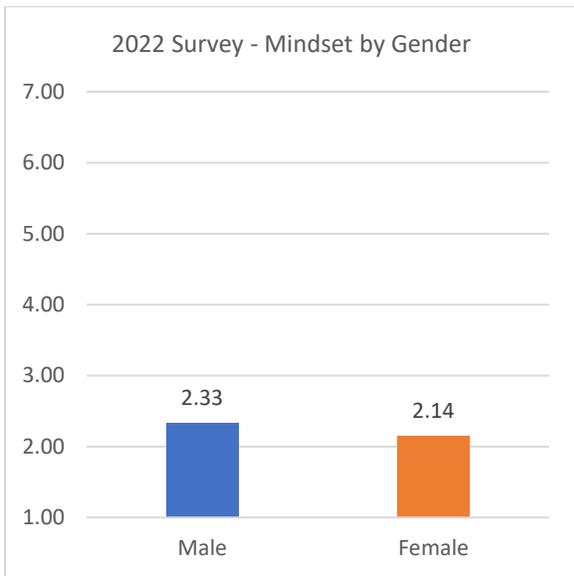
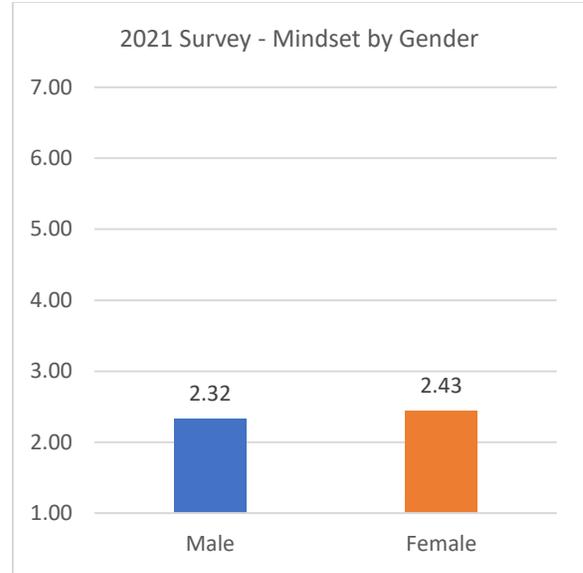
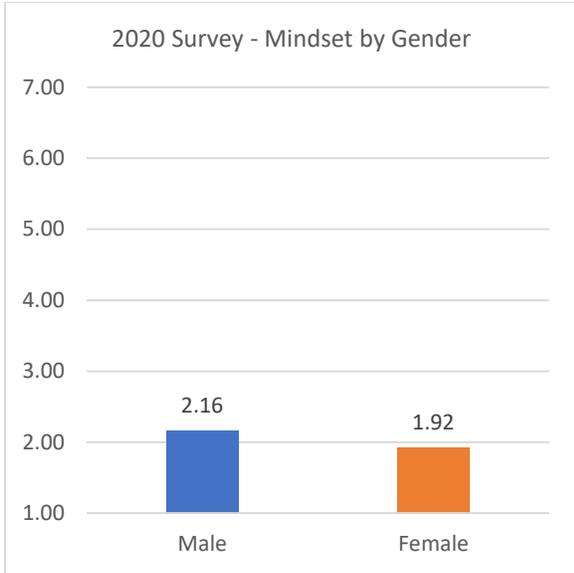
Number of items: 6

Interpretation of the scale: Higher fixed mindset scores indicate that students believe their talents and intelligence are not malleable

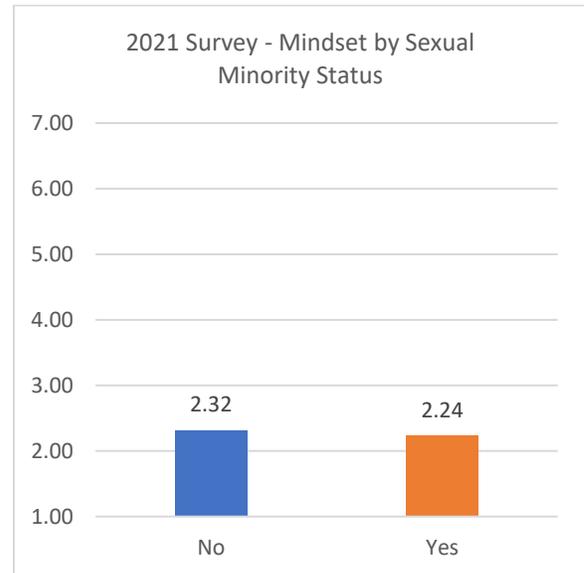
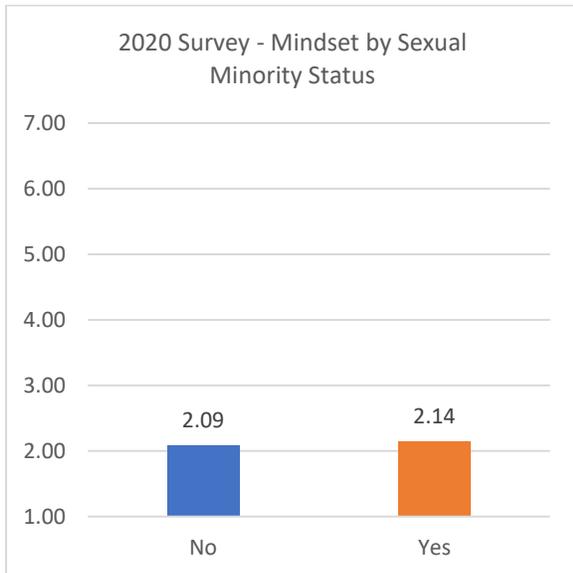
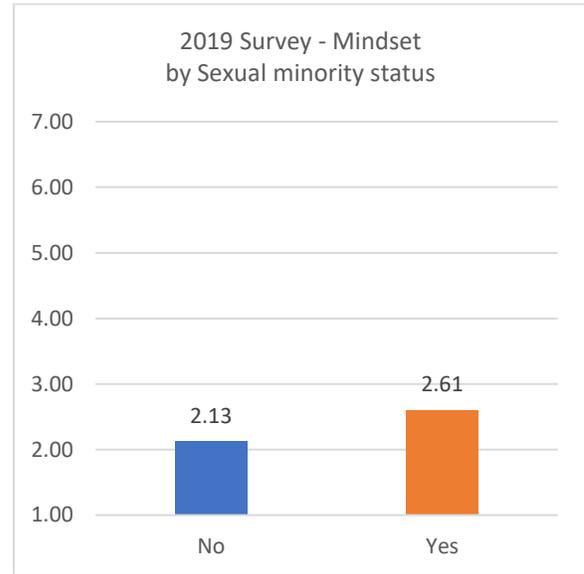
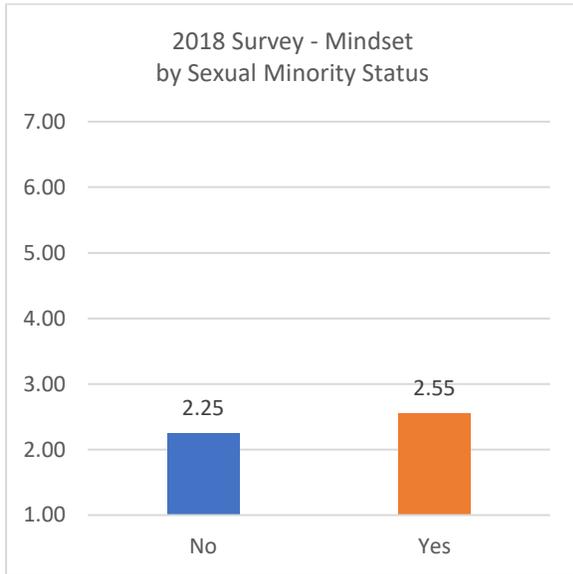
Malleability: Growth mindset can be taught to students. For example, "Saying is believing" exercises have been shown to help students sustain a shift from fixed to growth mindset [4]. Mindset interventions with undergraduate students have found mixed results [28]. However, there is evidence that mindset interventions can be effective in reducing the achievement gap for underrepresented minorities in college [1, 6, 90].

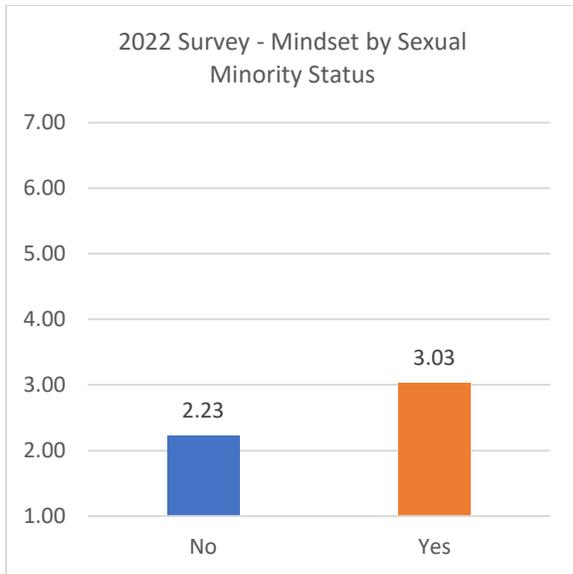
Gender



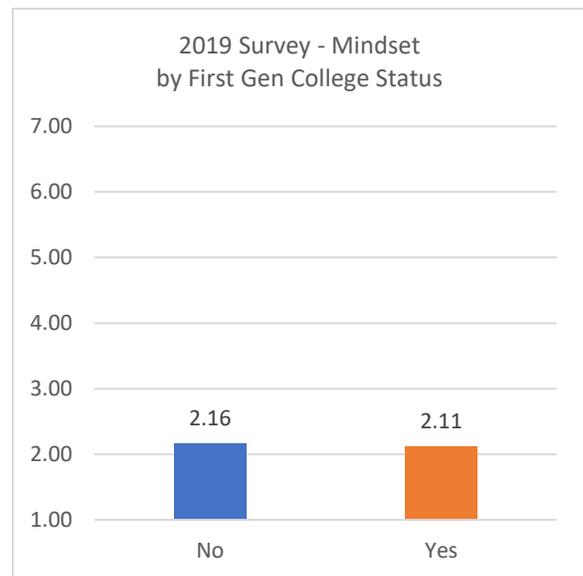
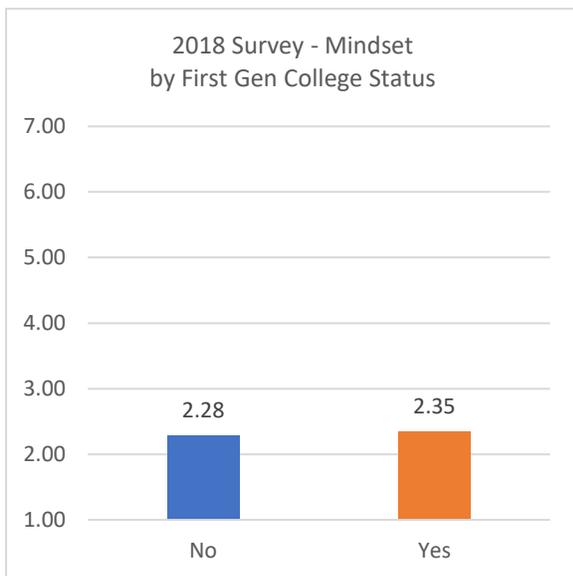


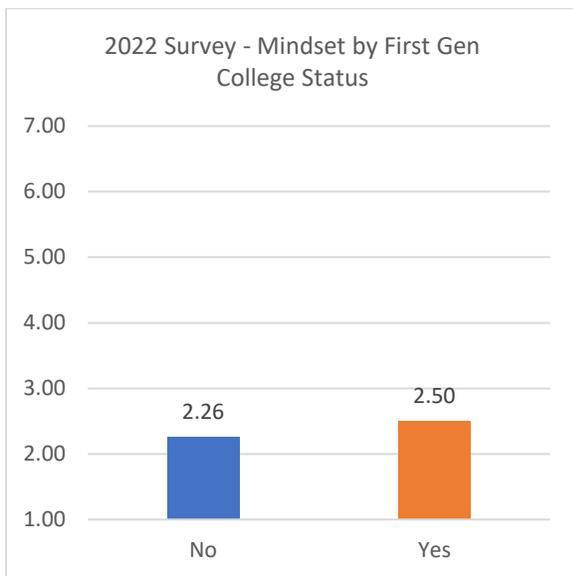
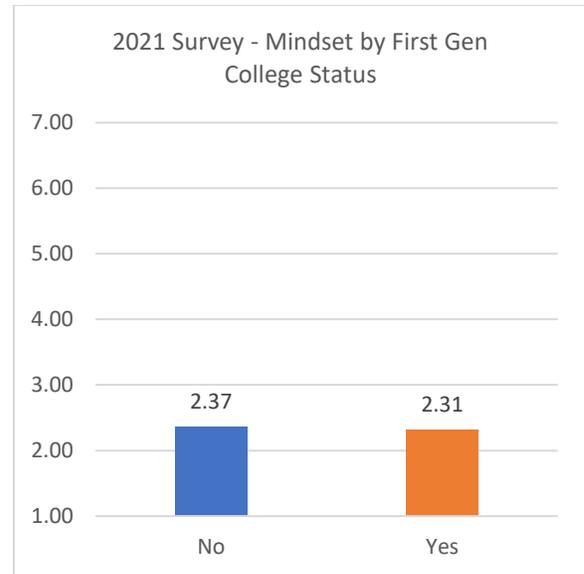
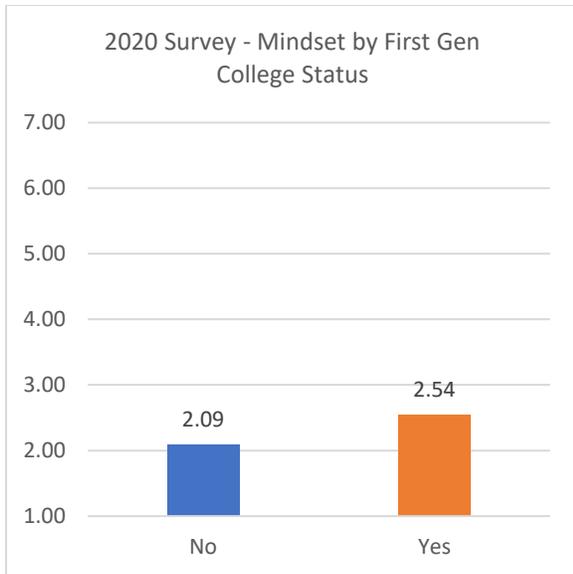
Sexual Minority Status



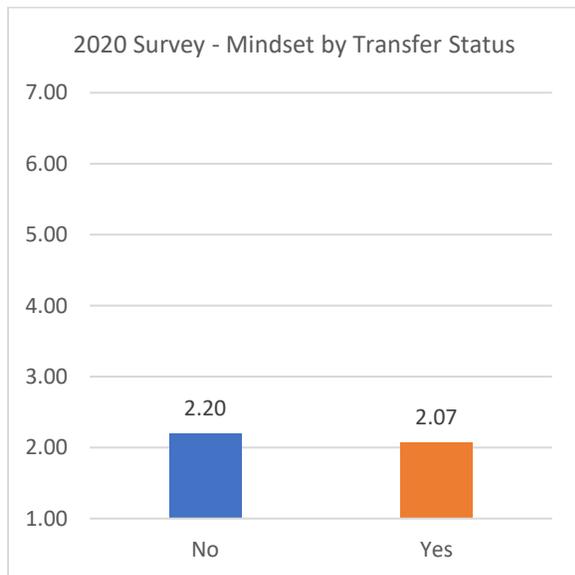
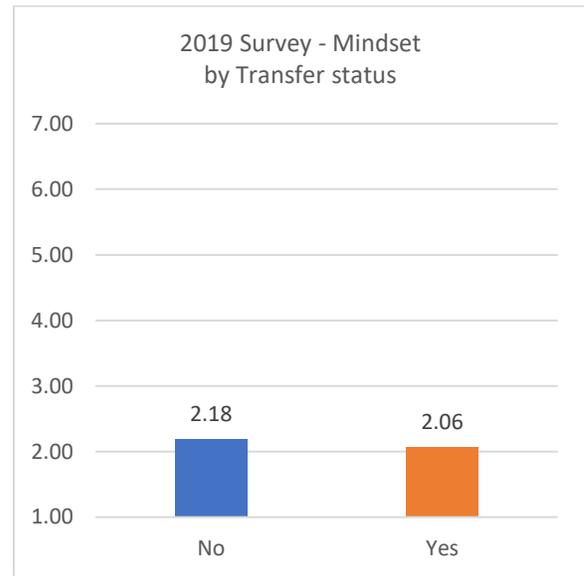
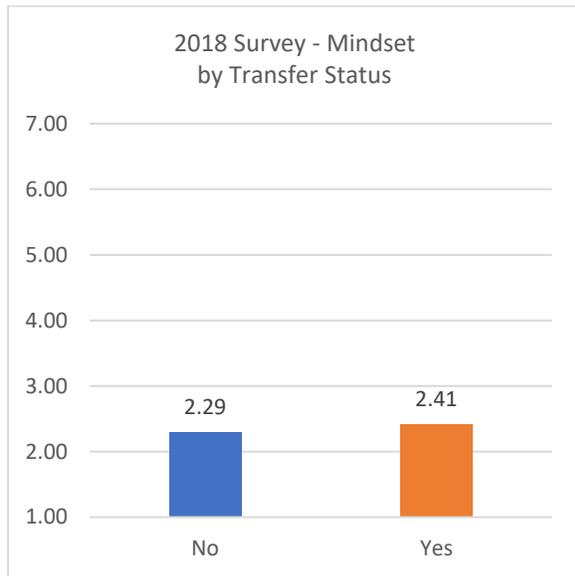


First-generation College Status



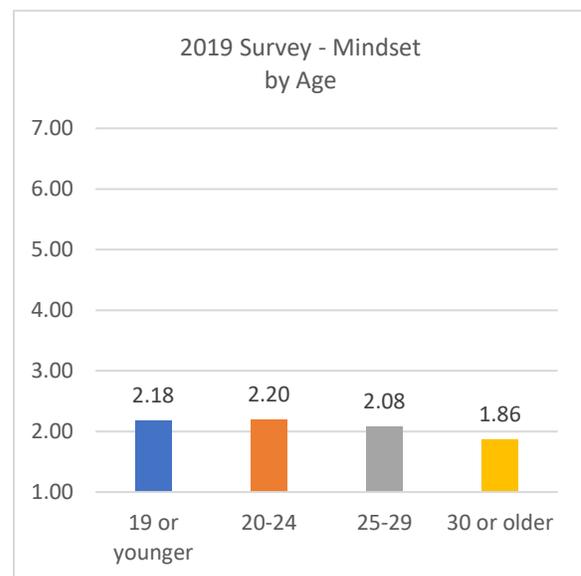
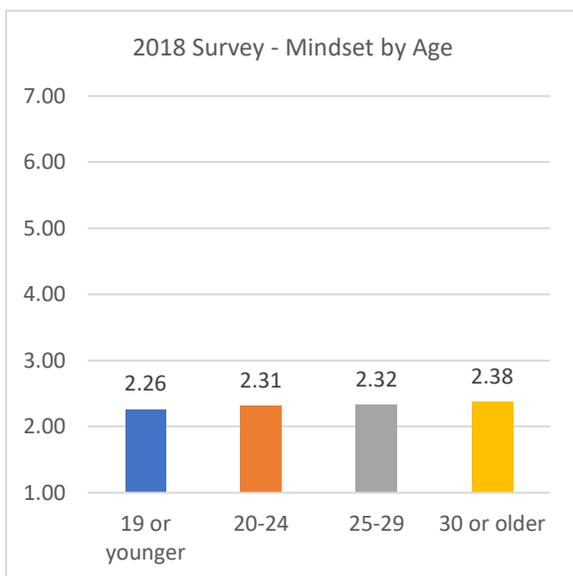


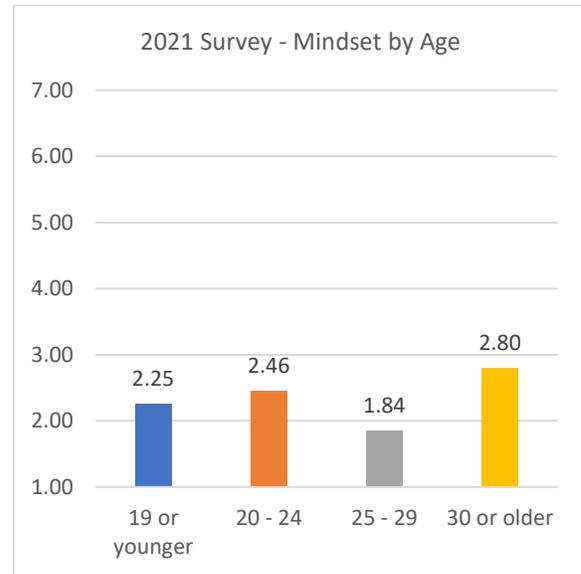
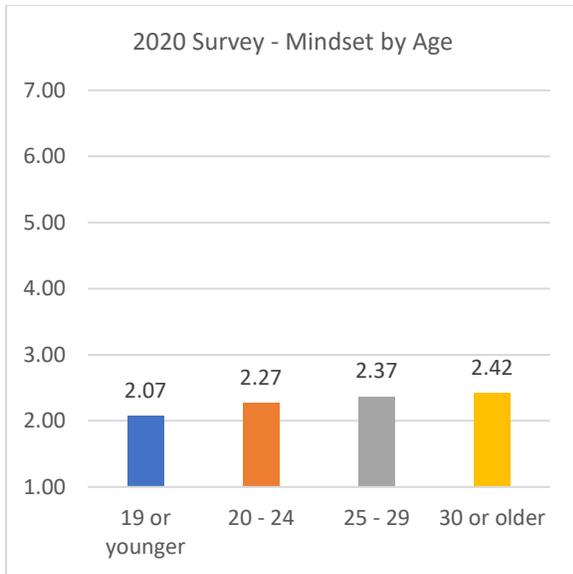
Transfer Status



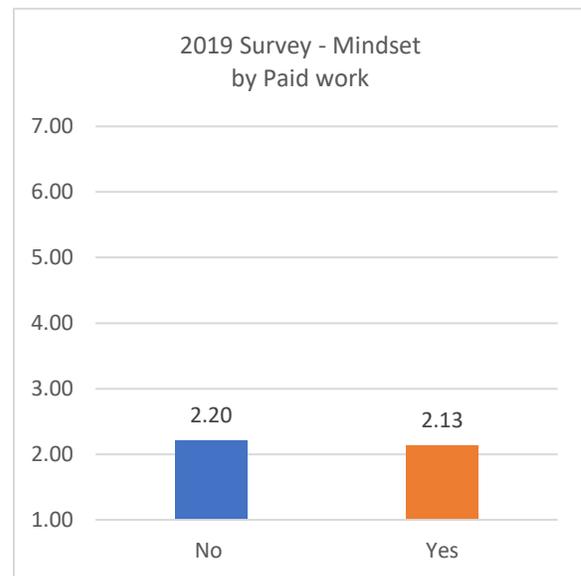
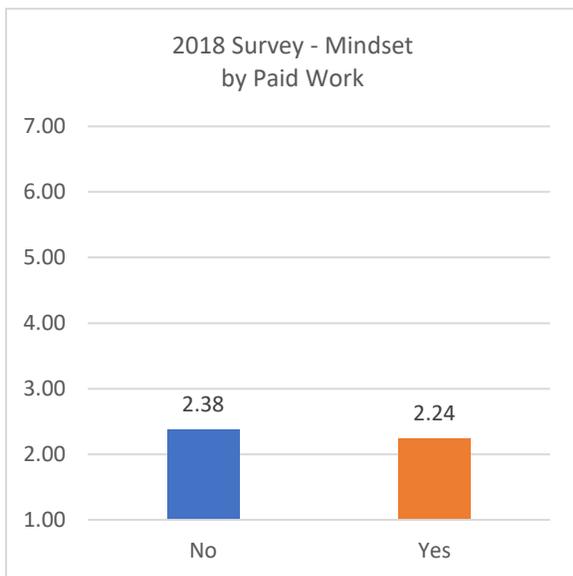


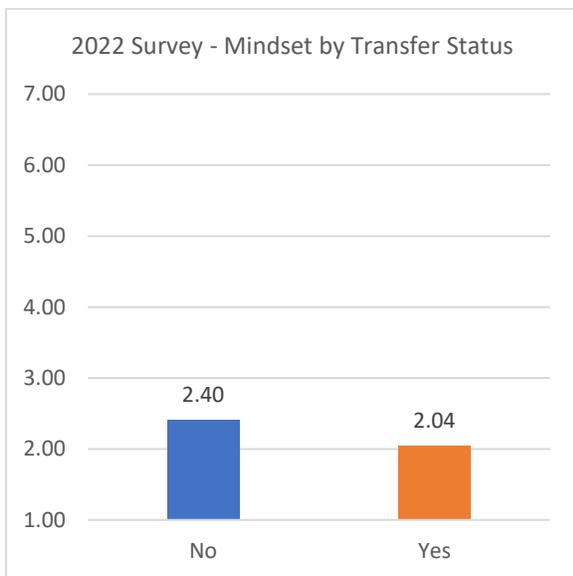
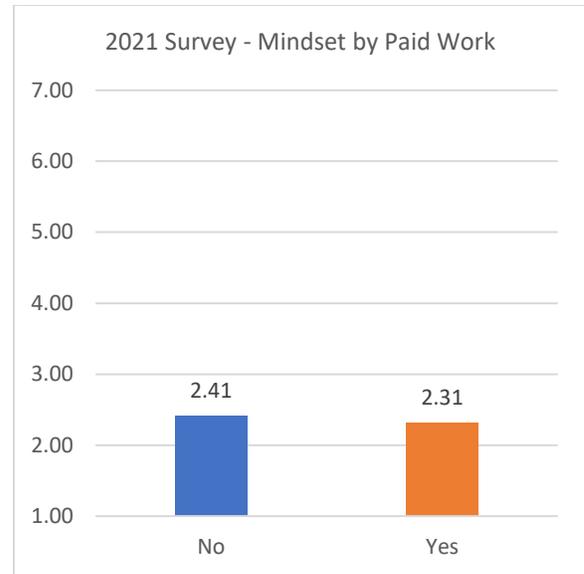
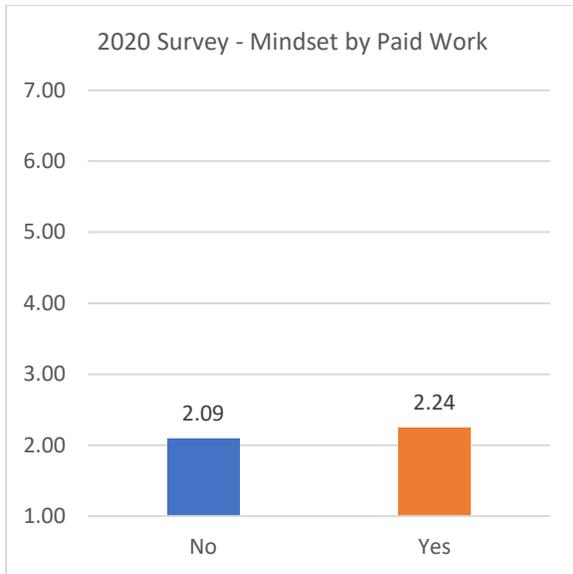
Age





Employment status





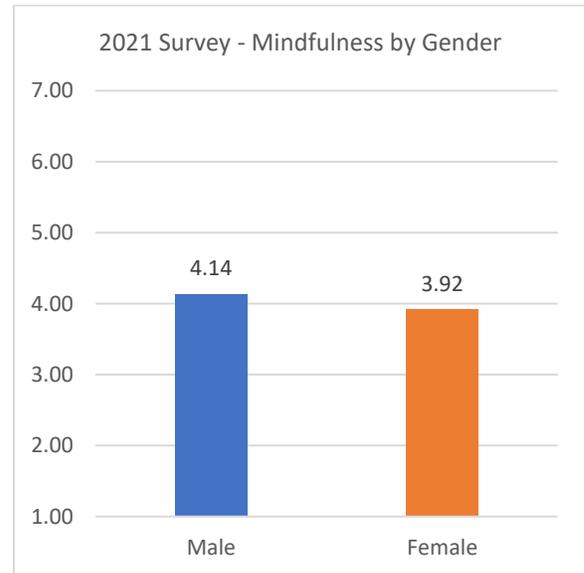
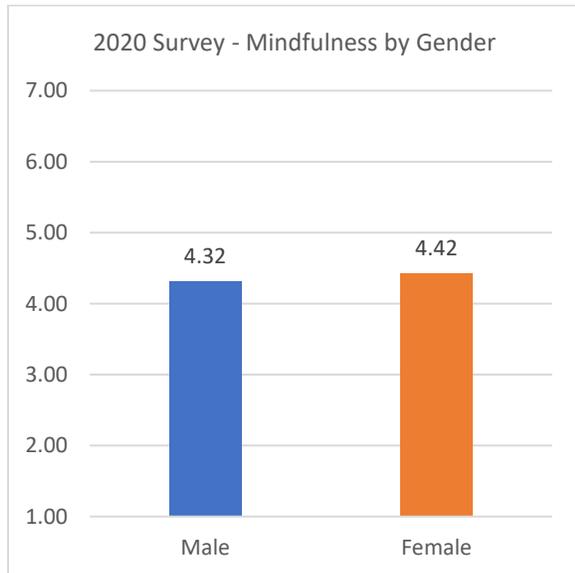
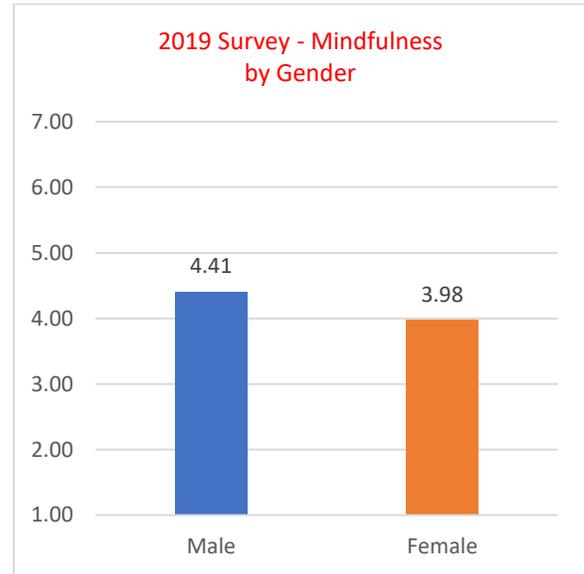
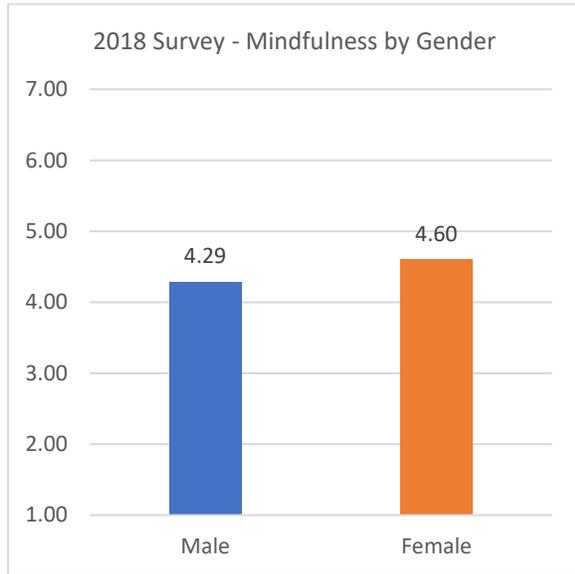
Mindfulness

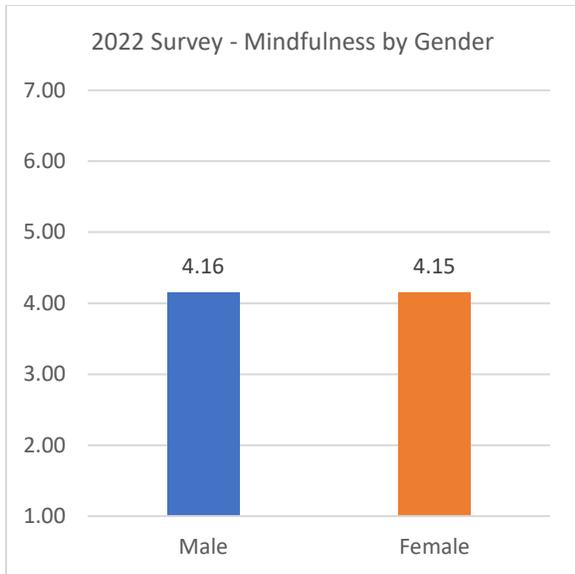
Mindfulness is defined as intentional, purposeful, focused, and nonjudgmental awareness [50, 32]. Although often associated with Buddhism, it is conceptualized as a universally applicable practice and an innate human capacity [32]. Neuroscience studies have indicated that mindfulness cultivates attention, creativity, and increased cognitive performance [92, 88]. Mindfulness has been implemented in several school curricula to help students improve focus, sleep, emotional self-regulation, self-control, relationships, executive functioning, and resilience to adversities and stressors [73, 66, 9], though most studies were conducted with participants from K-12 schools.

Number of items: 4

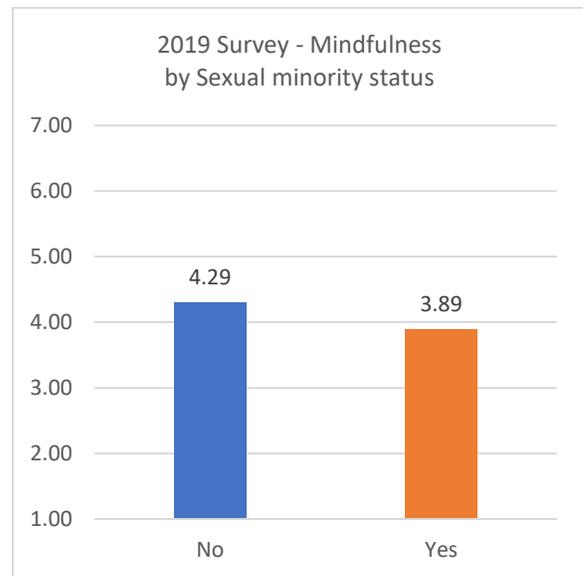
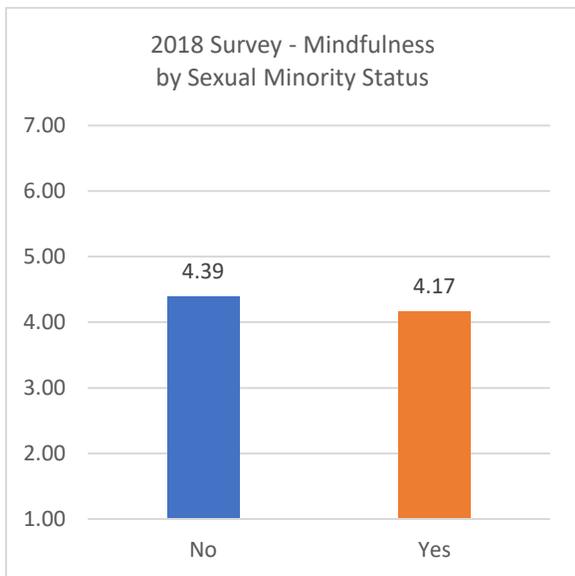
Interpretation of the scale: Higher mindfulness scores indicate that students experience greater moment-to-moment awareness

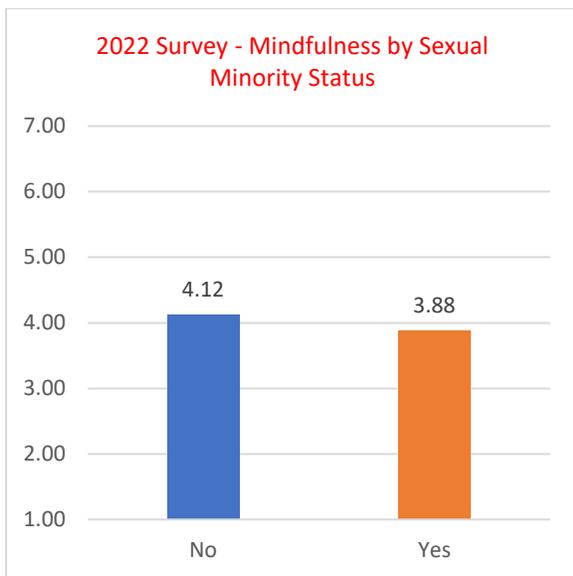
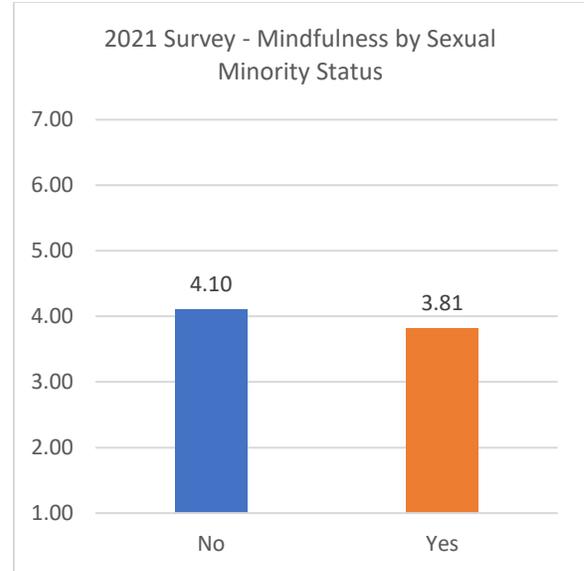
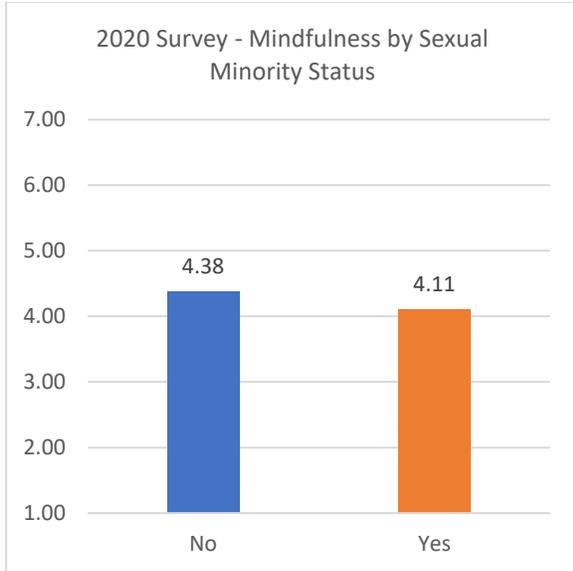
Malleability: Mindfulness is considered malleable and teachable in educational settings. Mindfulness can be cultivated through workshops for students at lunch areas or study halls [7], movement based courses such as Pilates or Taiji quan [9], notifying students of free online guided meditations (such as through YouTube) and apps (such as Headspace, Sattva, iMindfulness, and Smiling Mind), and subsidizing costs for mindfulness retreats designed specifically for college students (such as YesPlus or Koru).

Gender

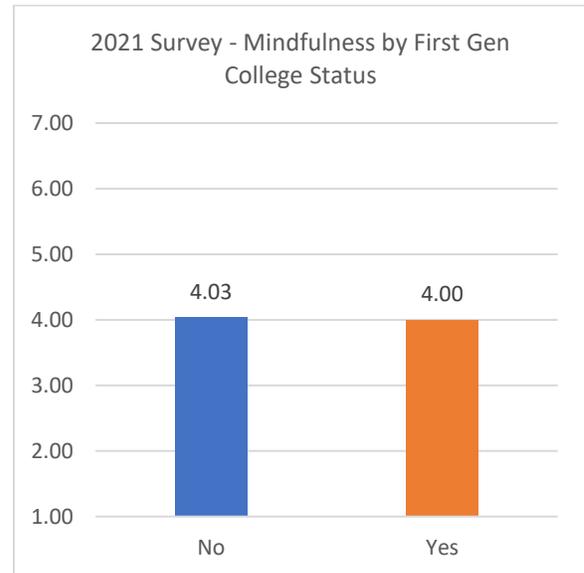
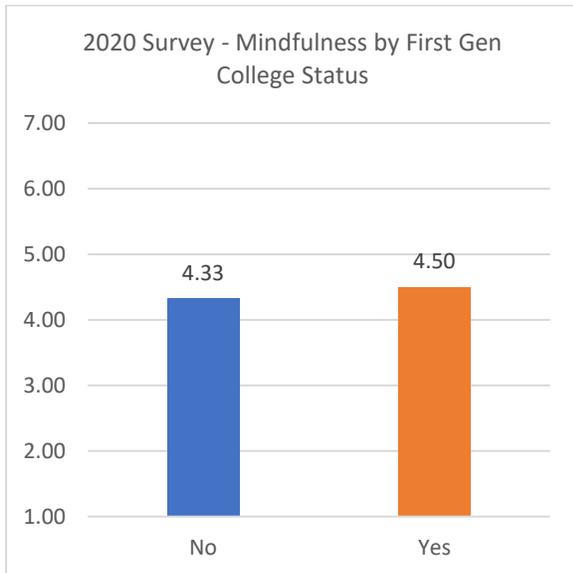
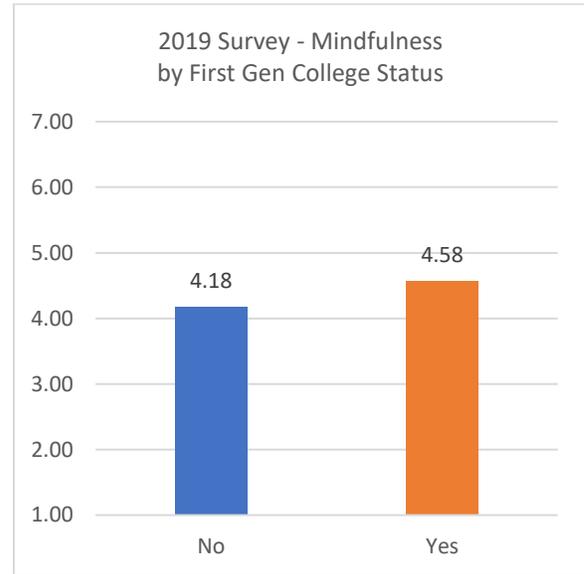
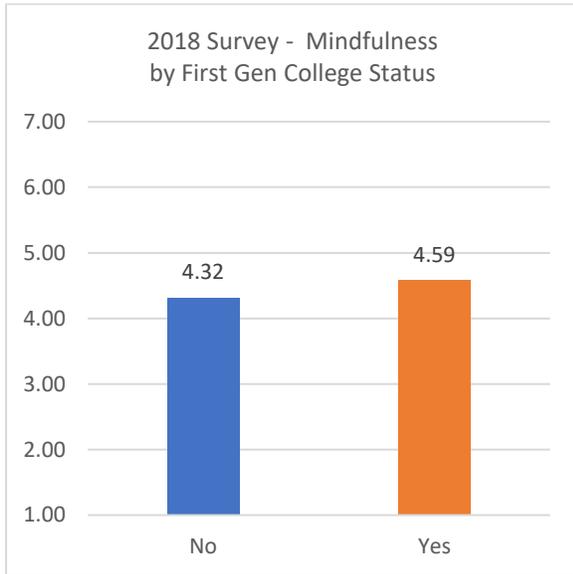


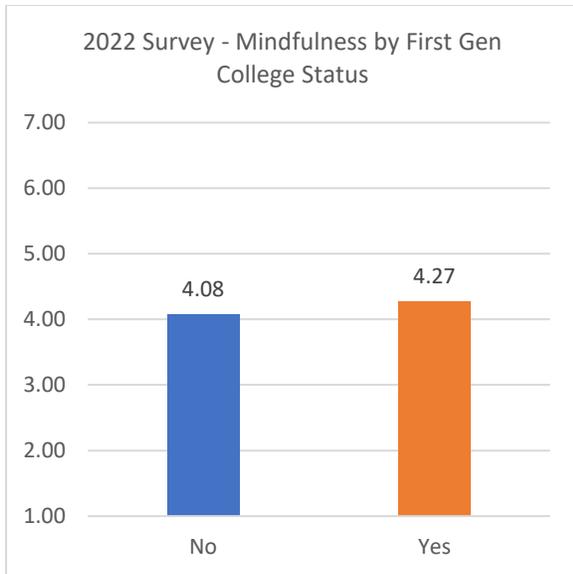
Sexual Minority Status



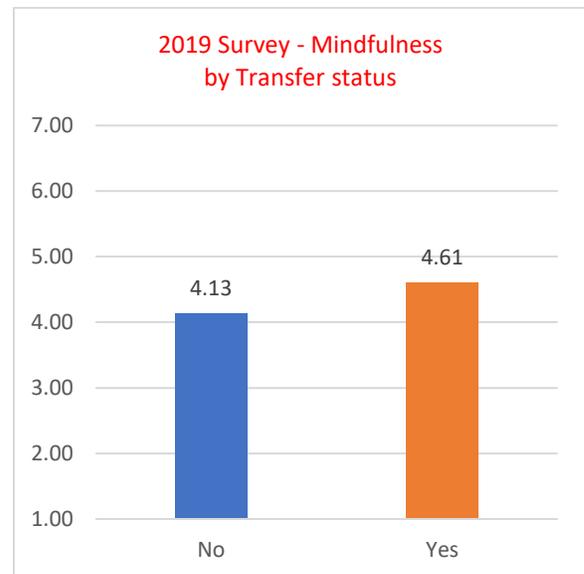
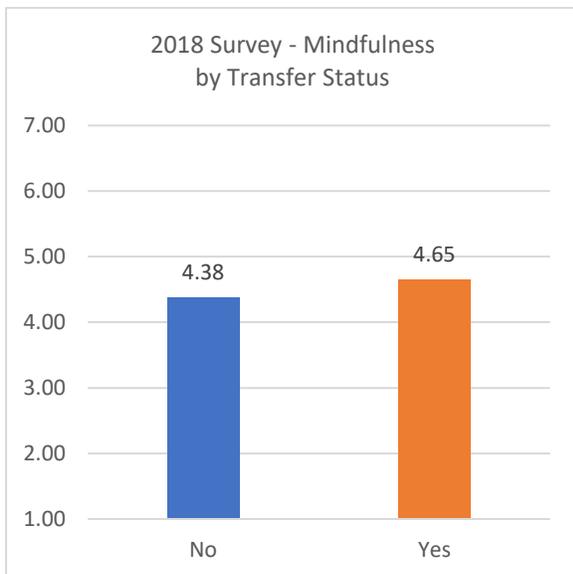


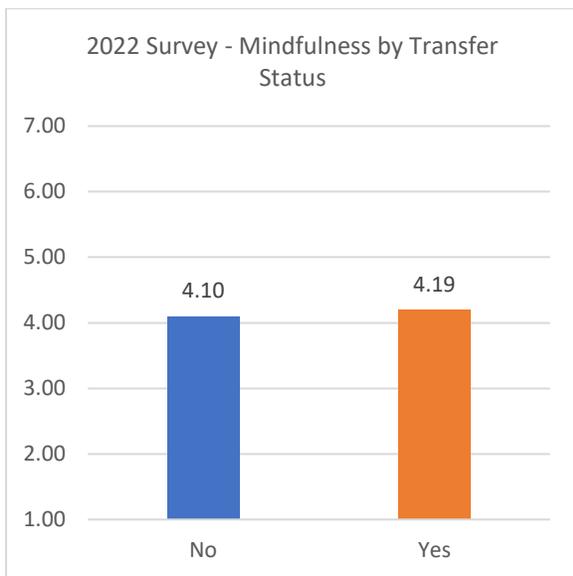
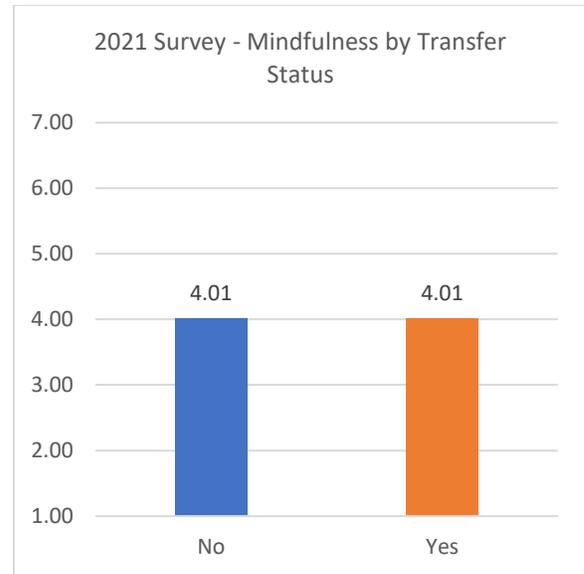
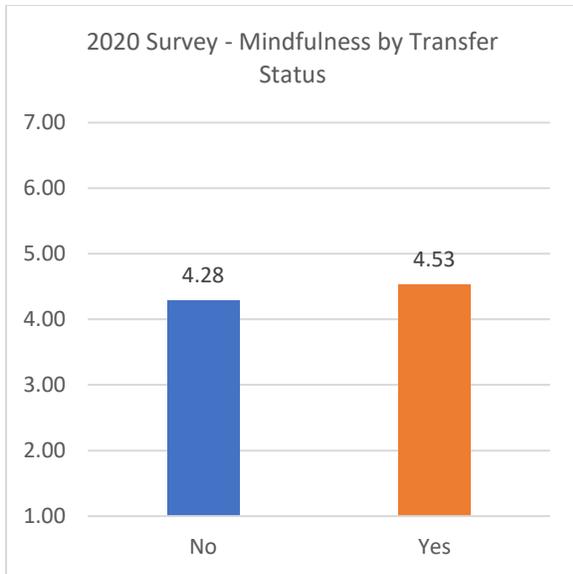
First-generation College Status



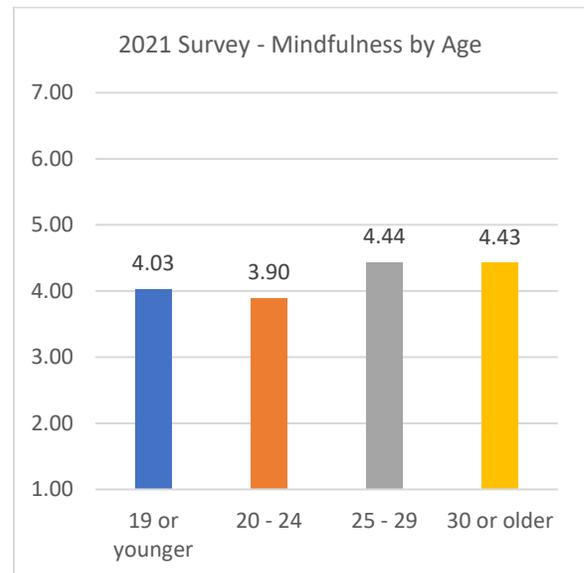
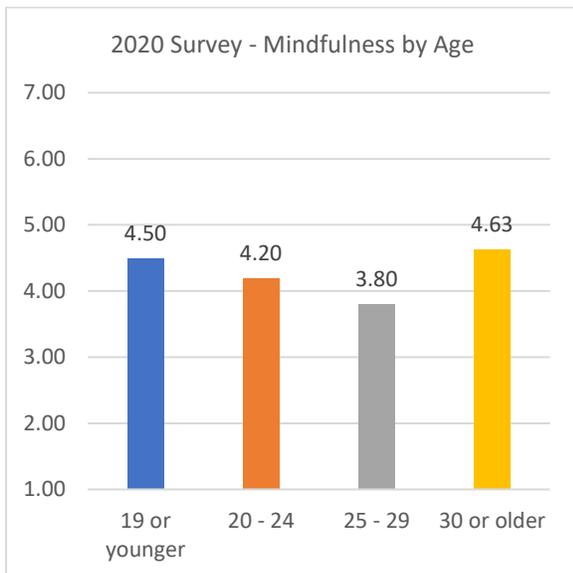
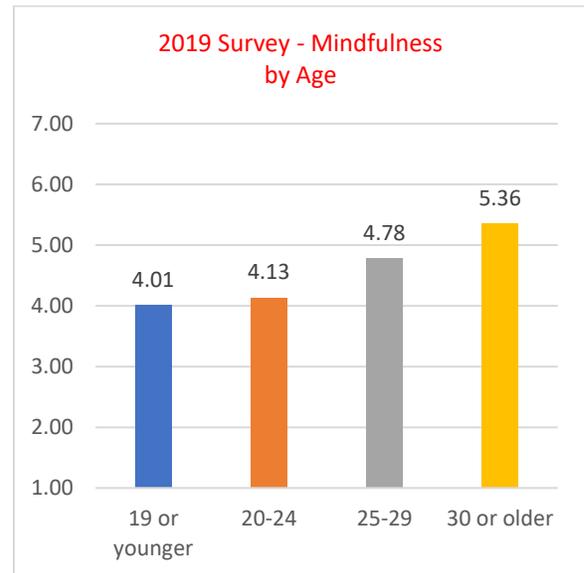
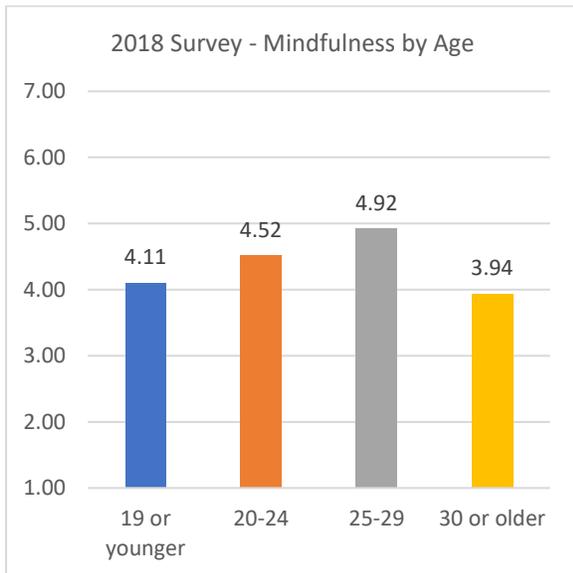


Transfer Status

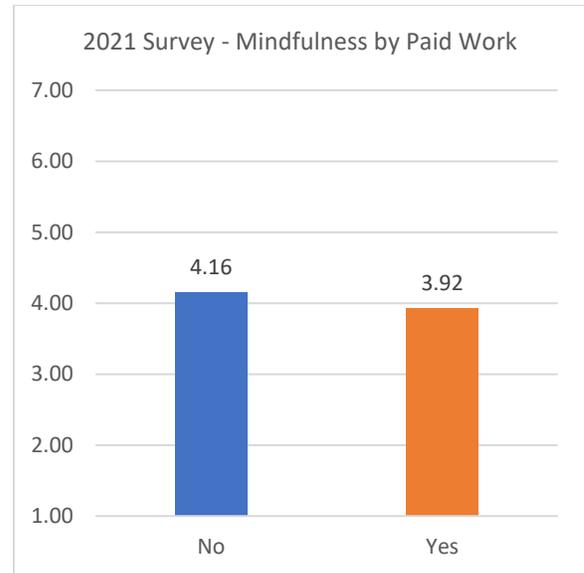
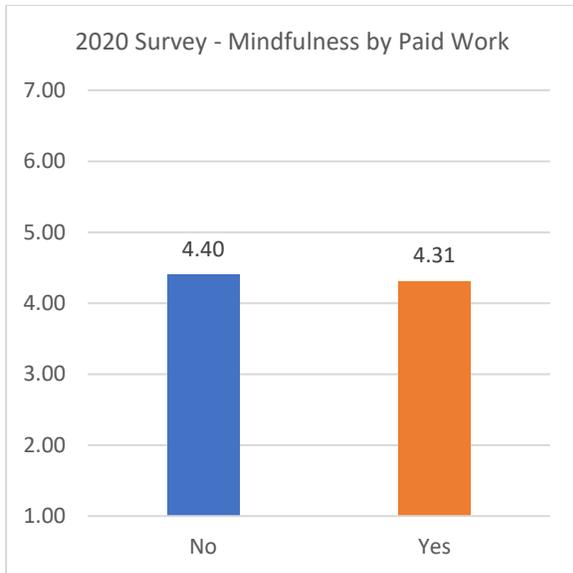
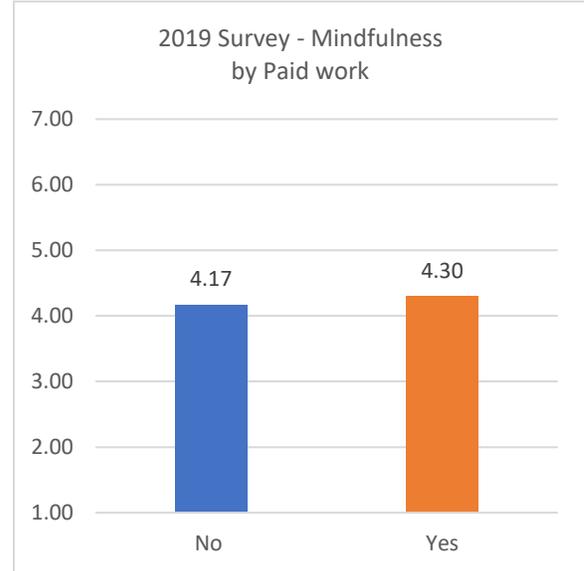
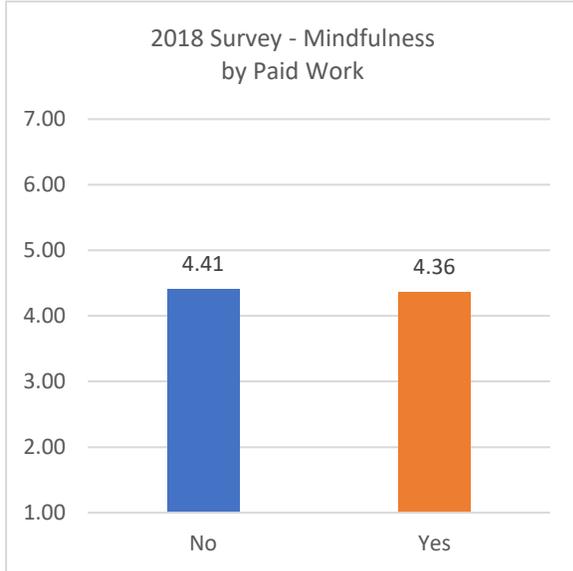


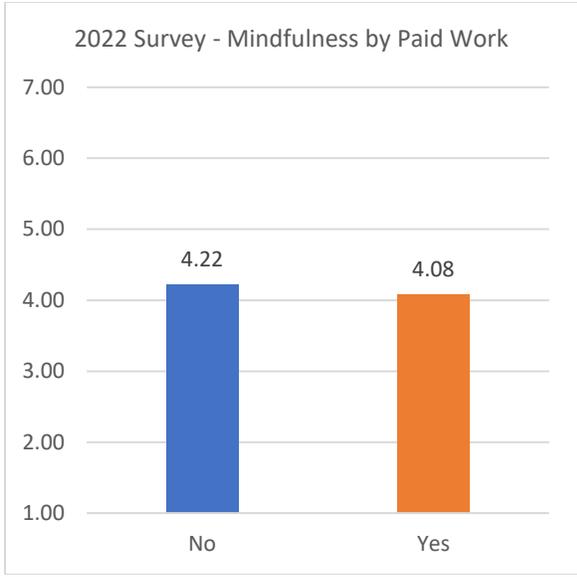


Age



Employment status





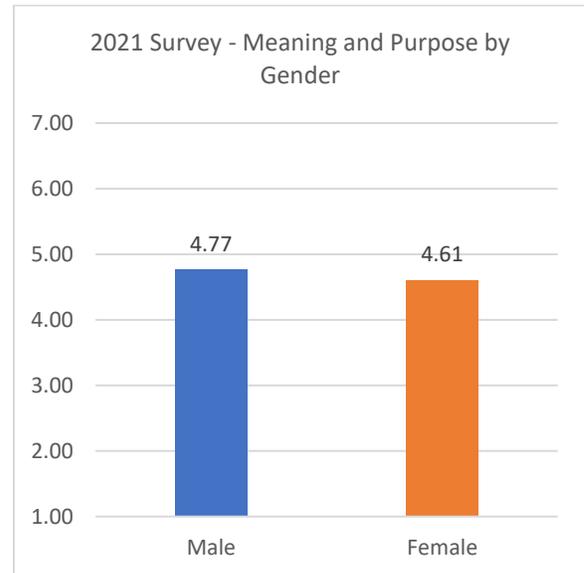
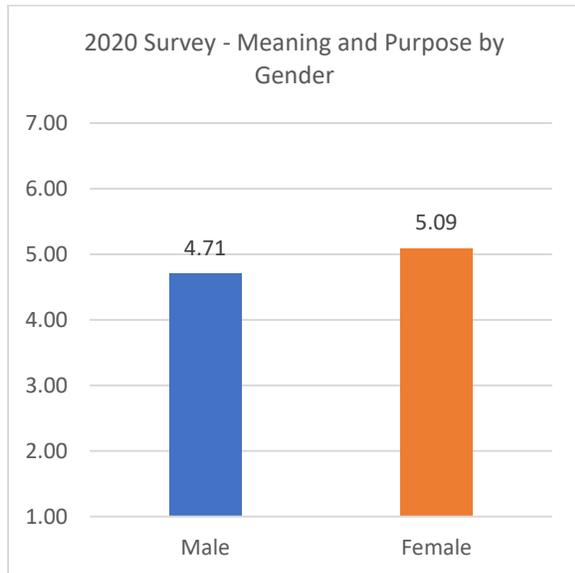
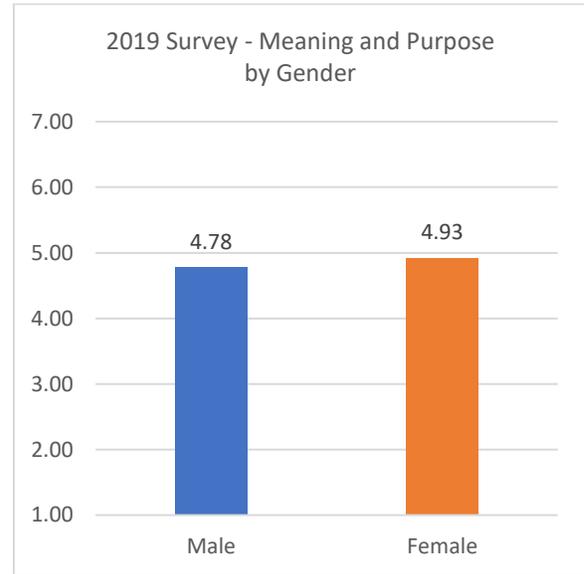
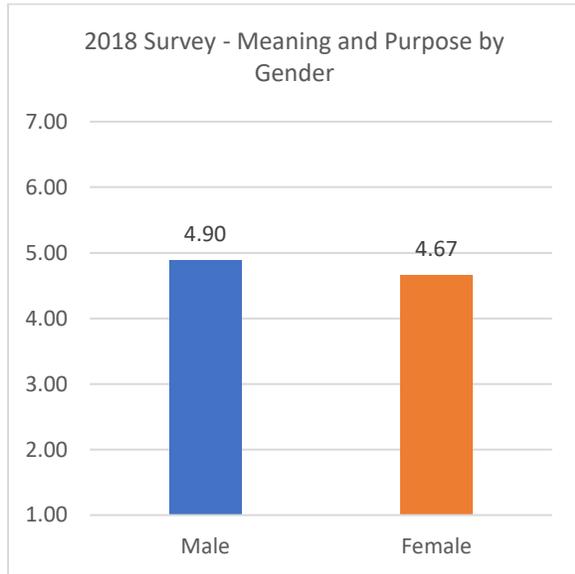
Meaning and Purpose

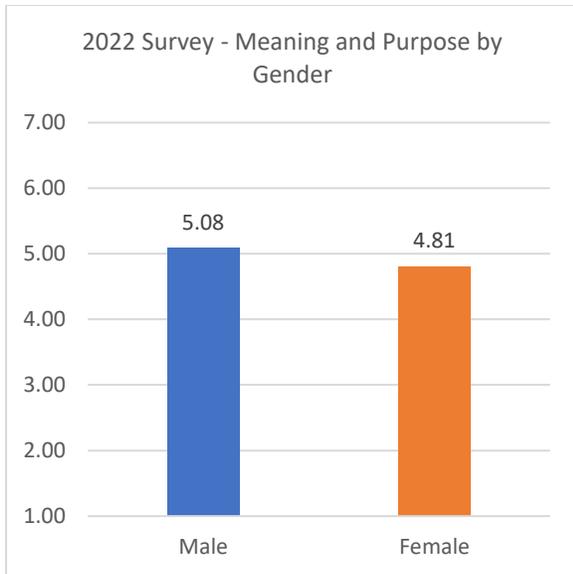
Meaning and purpose in life is a multidimensional construct that can be conceptualized as a set of values, actions, and goals that interact to create a sustained life purpose [68]. A greater sense of meaning and purpose in life is associated with a variety of desirable academic and personal outcomes, such as academic achievement, creativity, learning, motivation, character growth, and life satisfaction [29, 75, 14, 71]. While there are multiple measures of meaning and purpose, we used a subset of the Thriving Inventory [91] due to its conciseness.

Number of items: 3

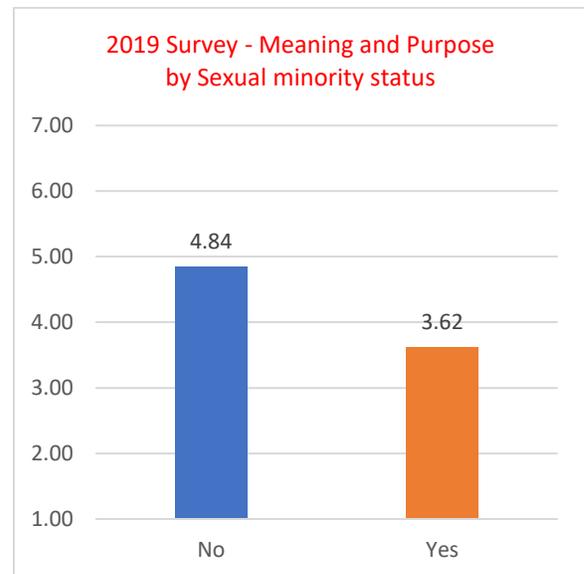
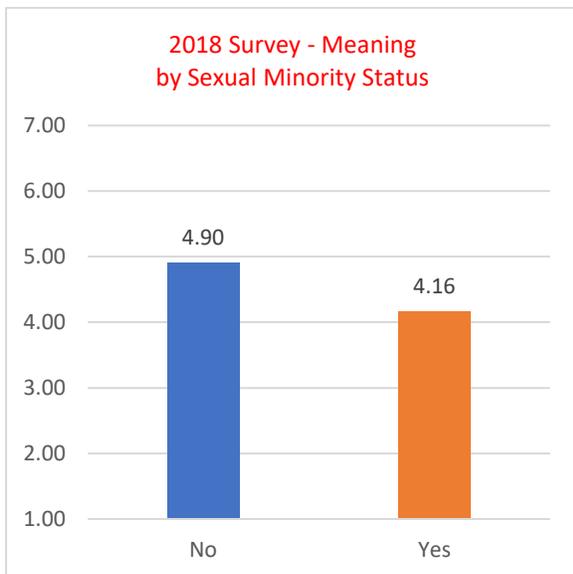
Interpretation of the scale: Higher scores indicate that students experience greater meaning and purposes in life

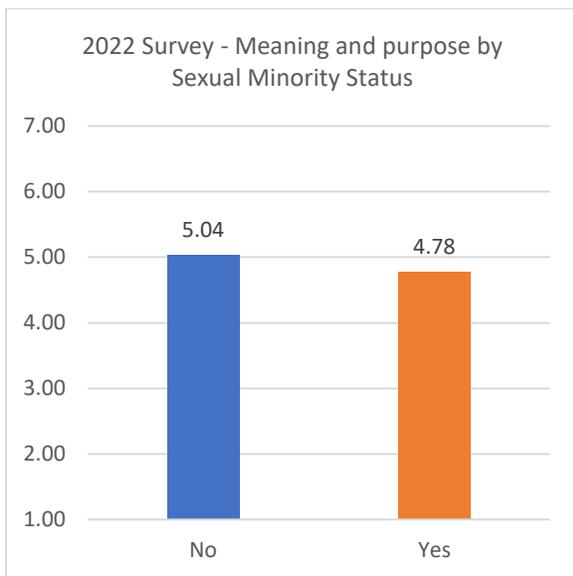
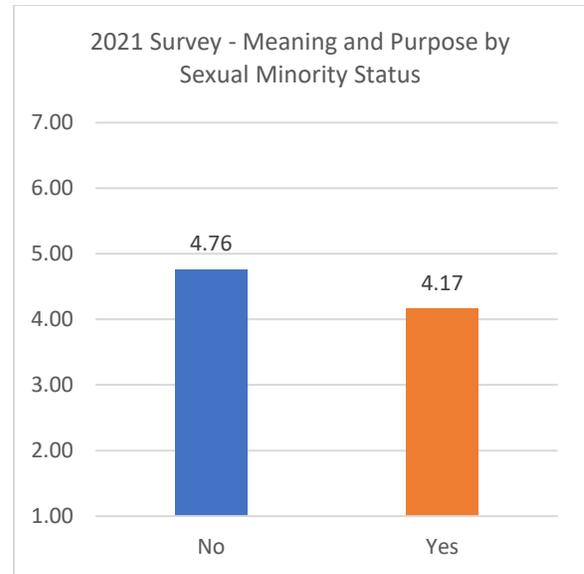
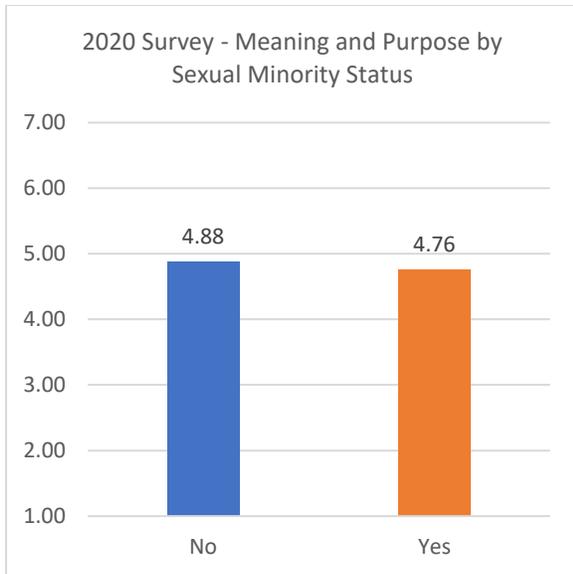
Malleability: A sense of meaning and purpose in life is considered malleable, and studies indicate that meaning and purpose can be taught in schools [85]. From a broader perspective, meaning and purpose can be cultivated through social connections [20, 24] and through serving something greater than oneself [85]. Instructors can encourage students to reflect on what gives life meaning and purpose, using a series of quotations on meaning and purpose for guidance [86], or have students and their parents engage in a 'meaning dialogue' regarding what makes life meaningful and purposeful [86]. Instructors can also encourage students to use their strengths to serve others without expecting anything in return [71], or have students direct more of their own learning in groups, especially ones that can impact the community [65]. Instructors can encourage students to participate in more peer support programs, taking on leadership roles, and developing a sense of pride and commitment to their school [71].

Gender

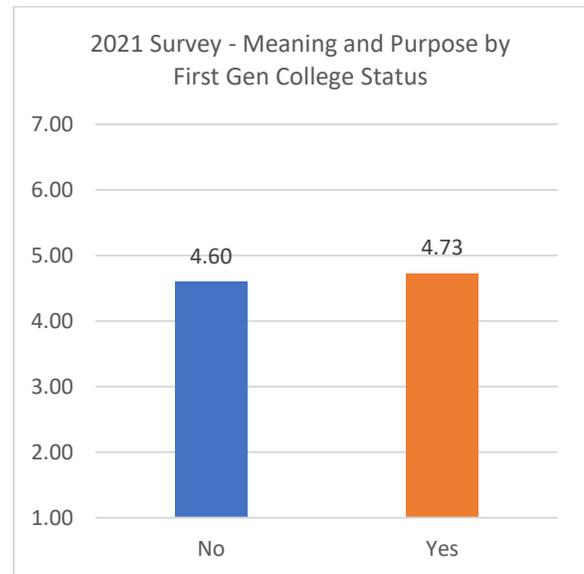
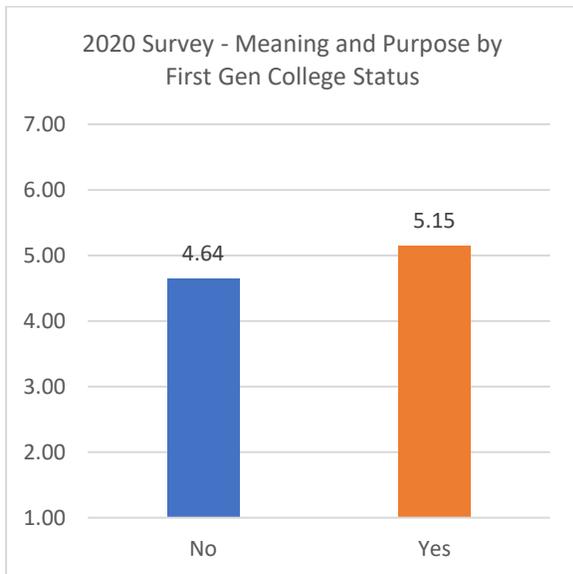
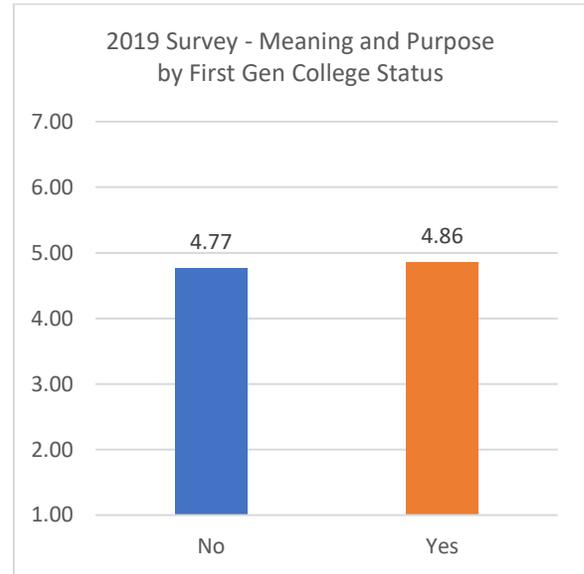
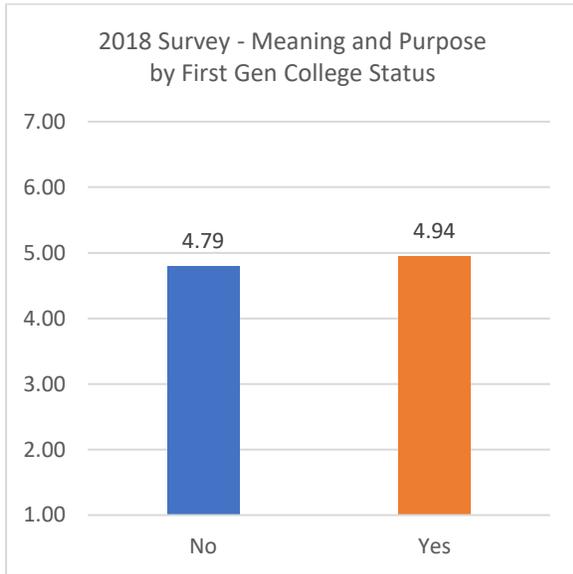


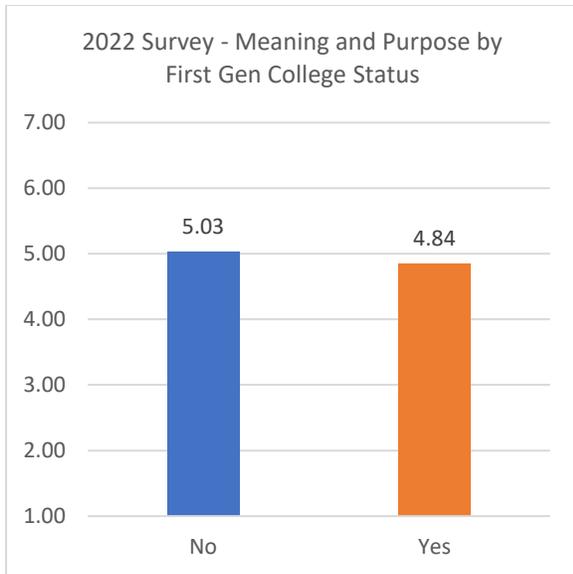
Sexual Minority Status



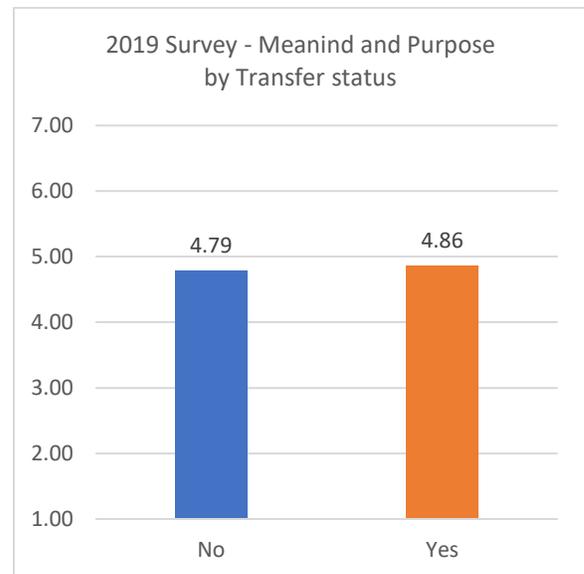
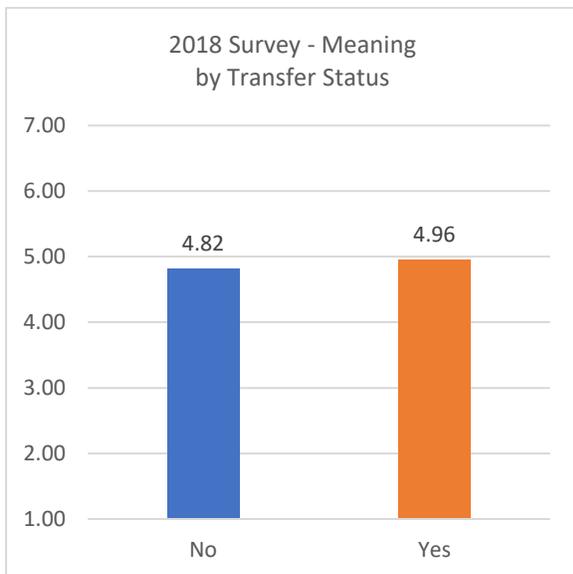


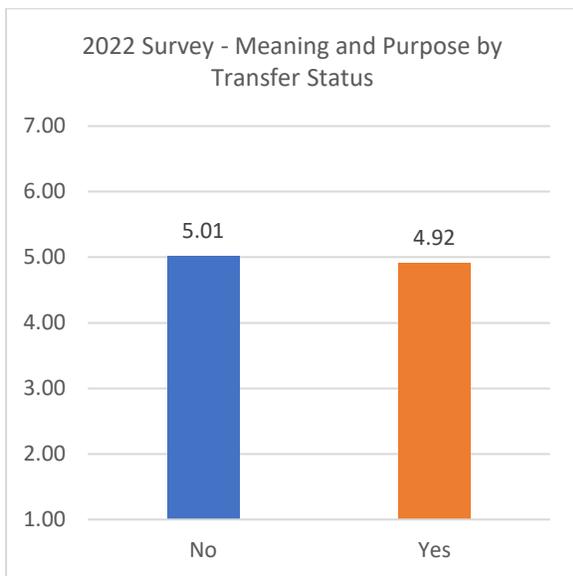
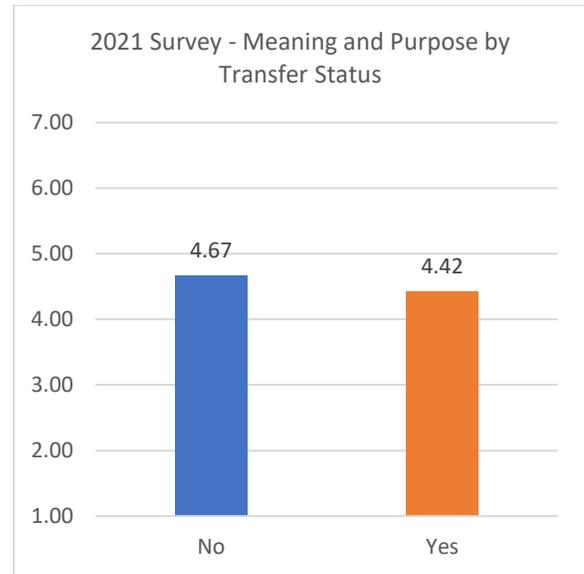
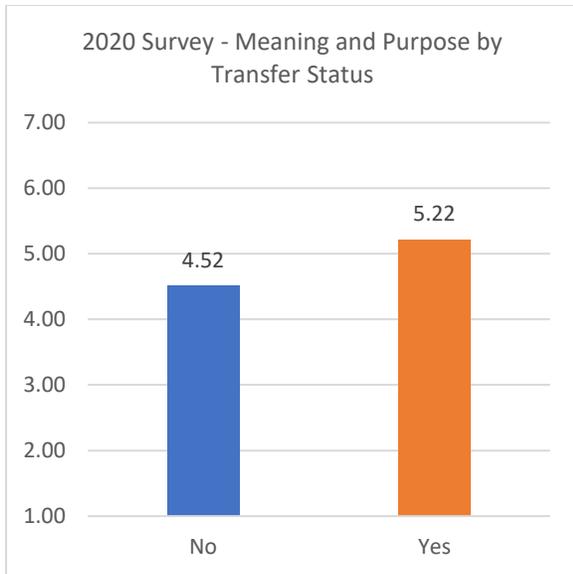
First-generation College Status



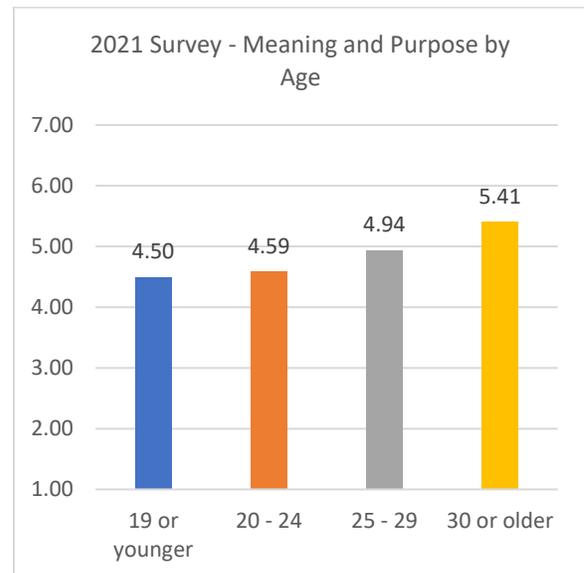
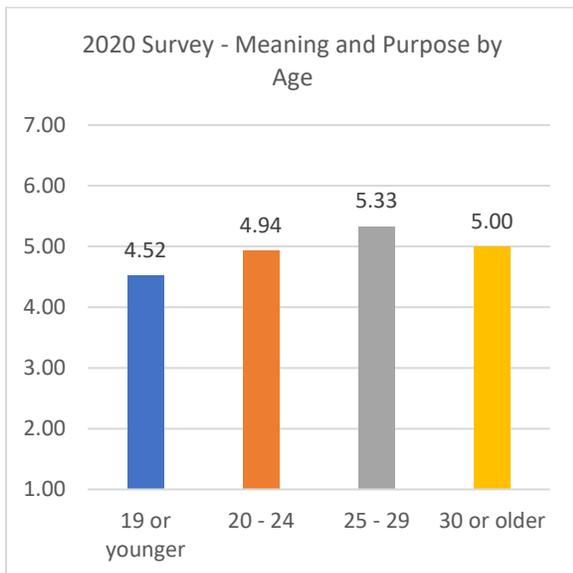
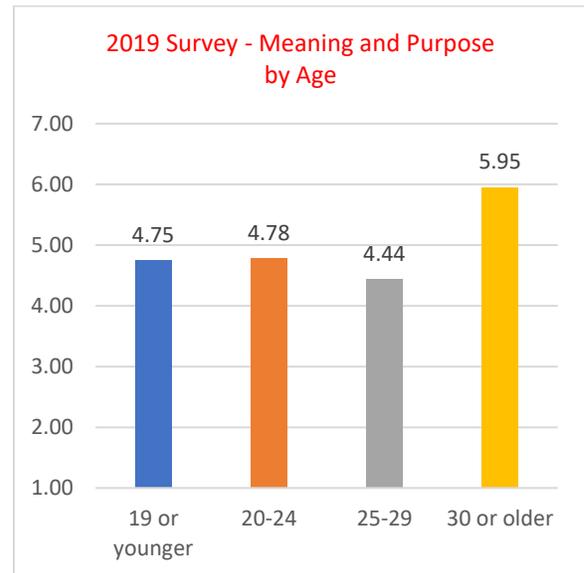
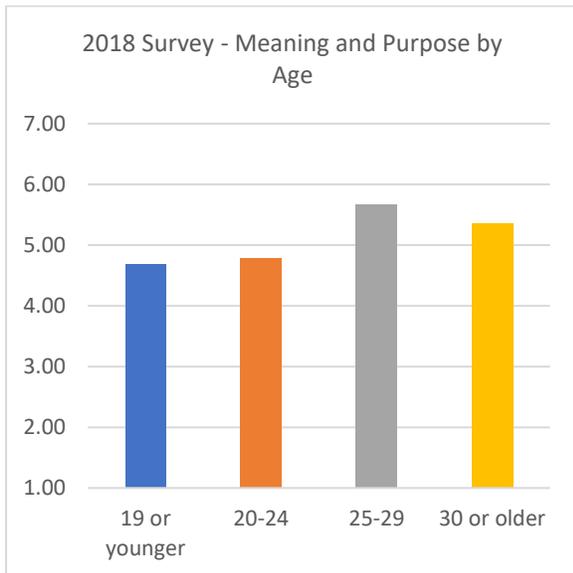


Transfer Status

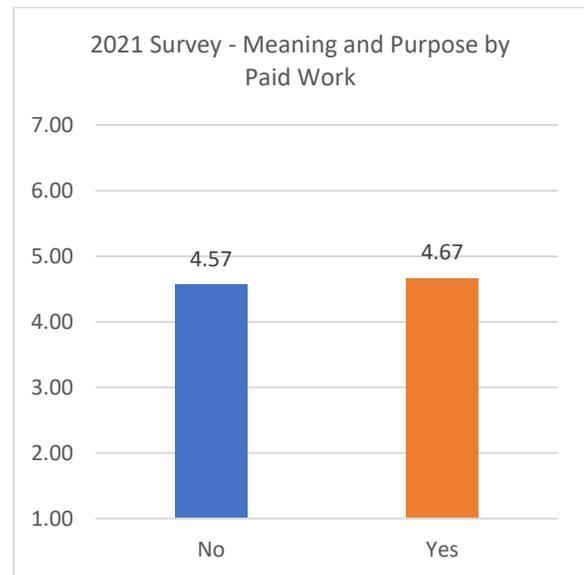
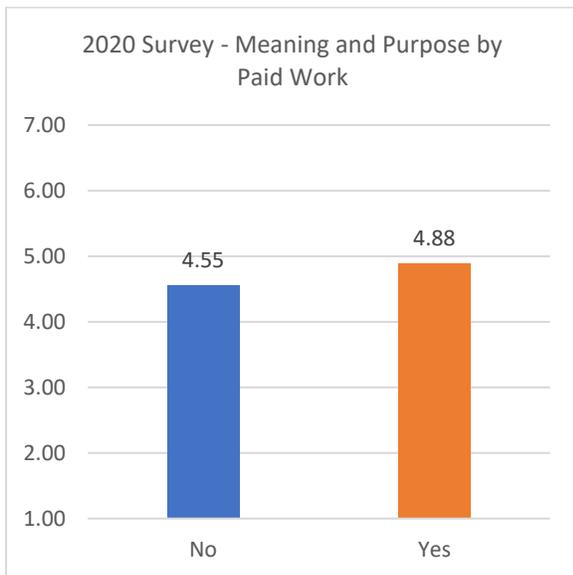
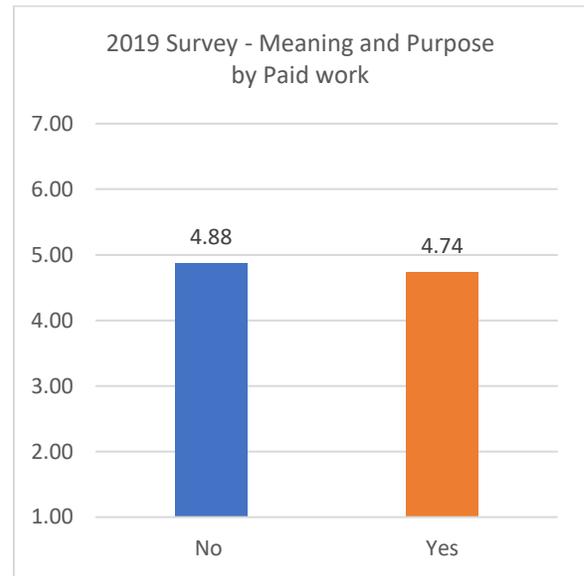
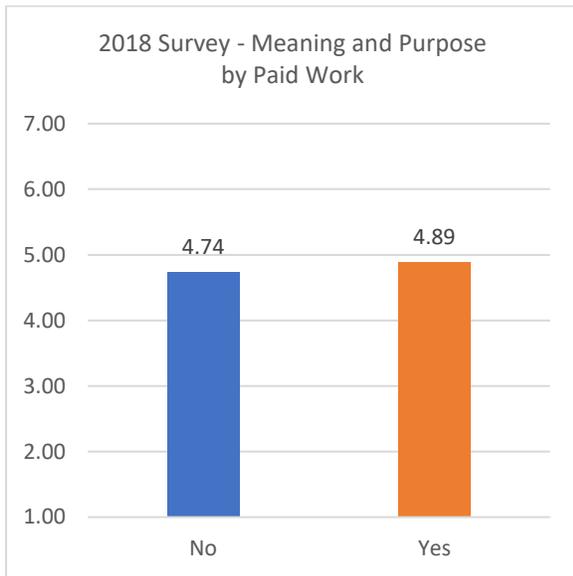


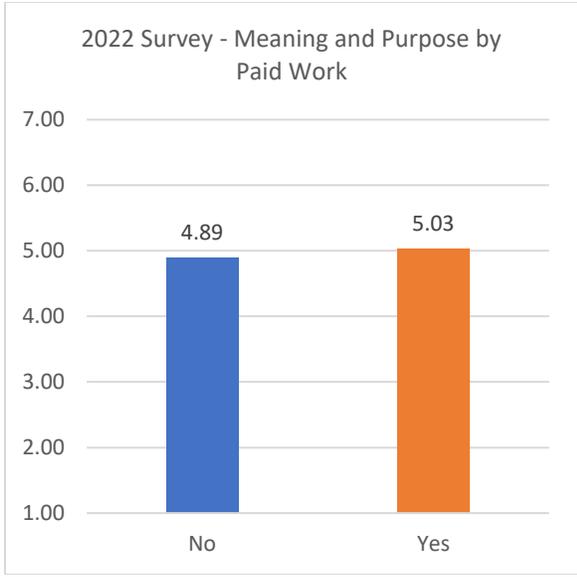


Age



Employment status





Belongingness

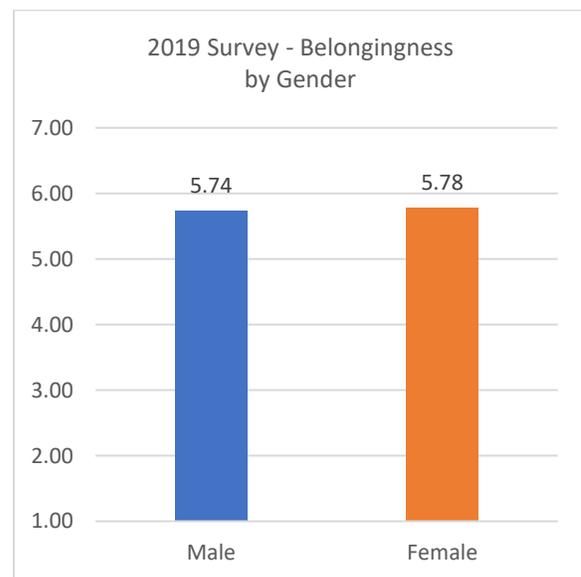
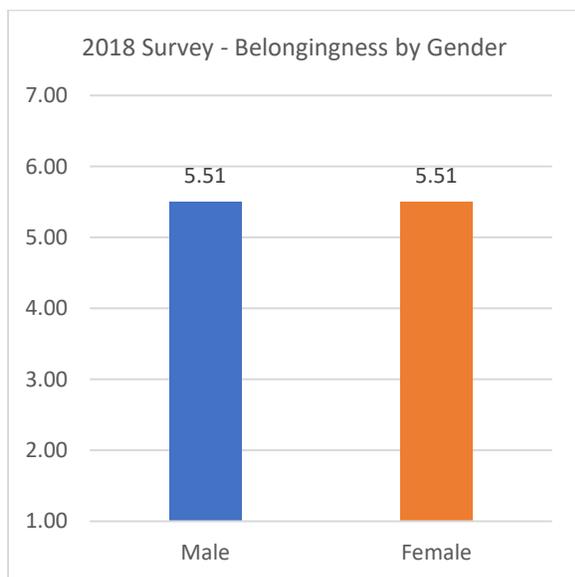
Sense of belonging or a student's belongingness is an important factor in STEM education and is considered a basic human need that is dependent on social relationships for fulfillment [61]. Indeed, one of the top reasons that students leave engineering is not academic preparedness but lack of belonging [36, 87]. We used four items to measure belongingness within the engineering and computing academic communities [52].

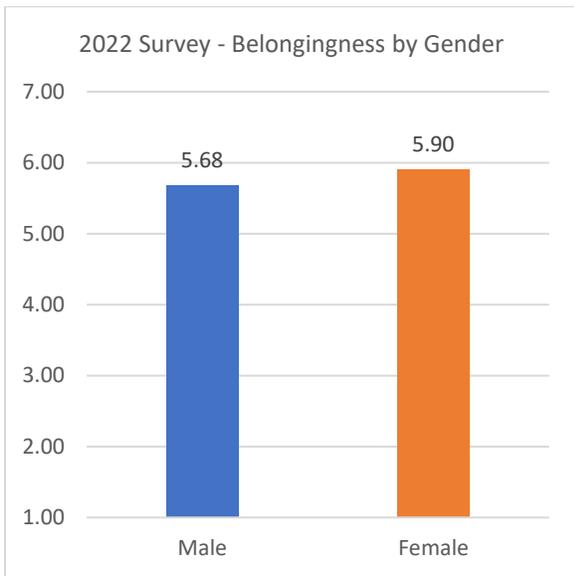
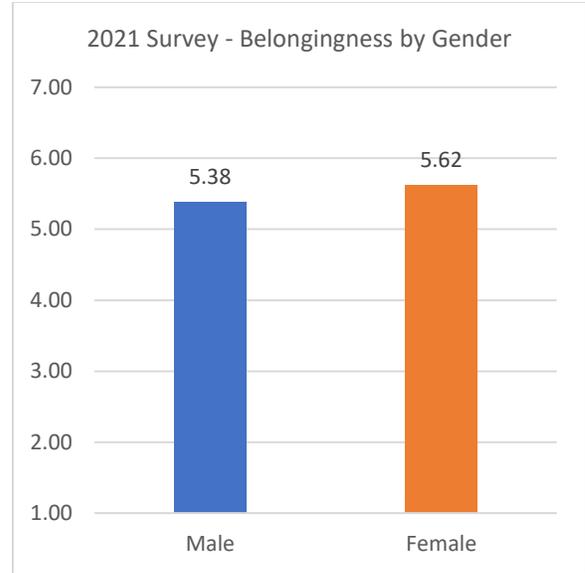
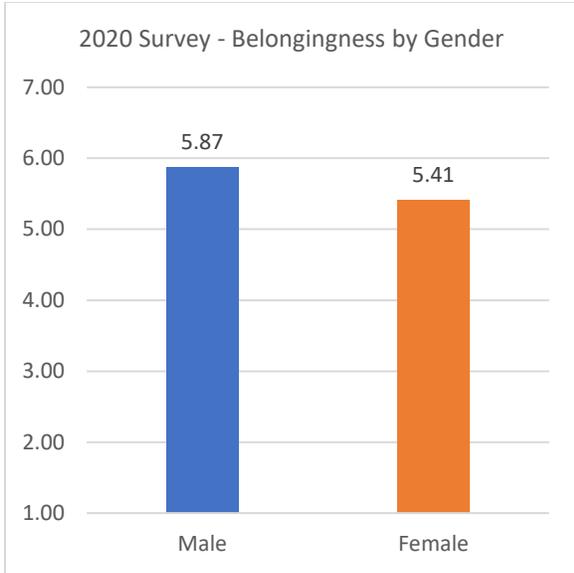
Number of items: 4

Interpretation of the scale: Higher scores indicate that students experience greater sense of belonging to their academic communities

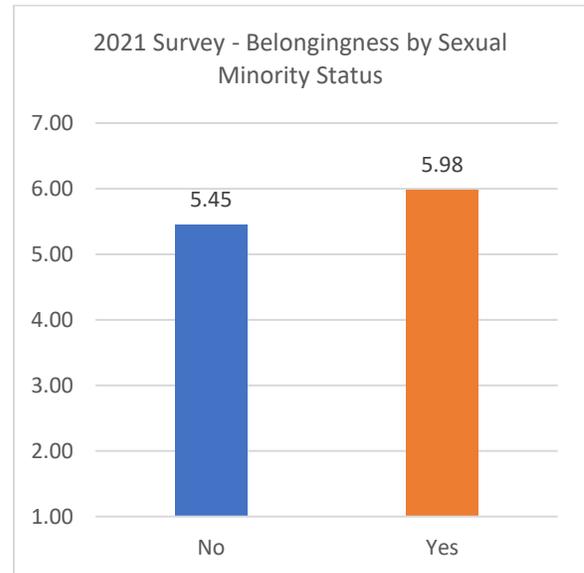
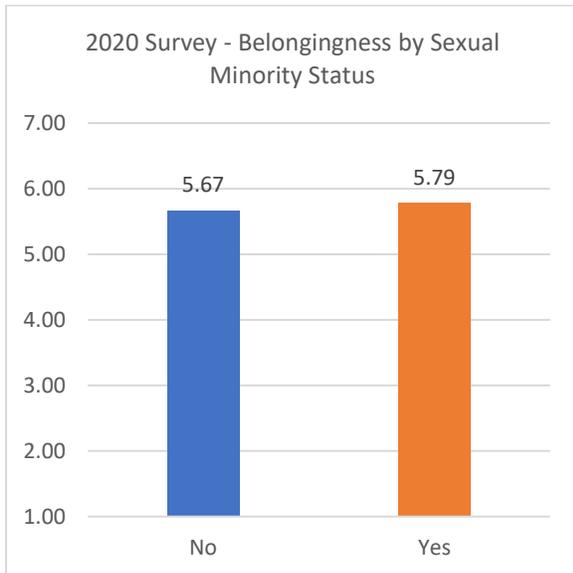
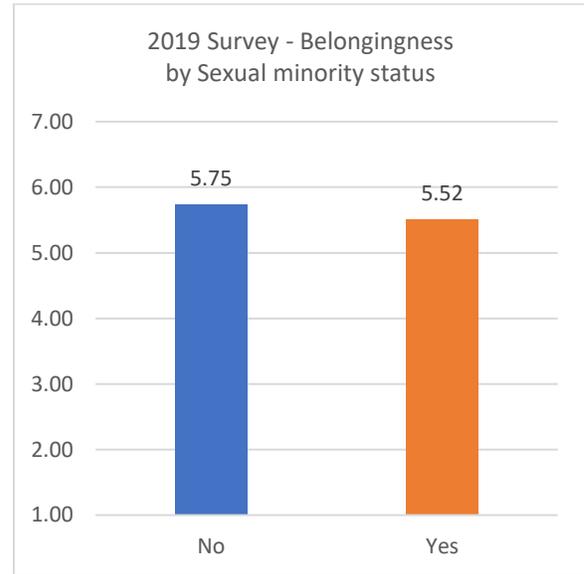
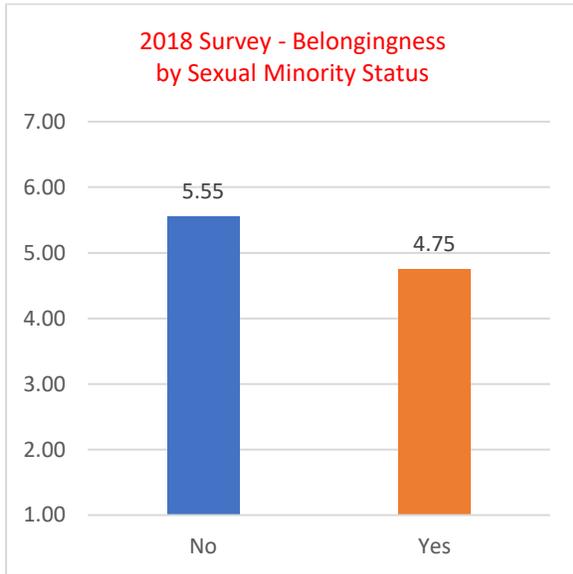
Malleability: A sense of belongingness can be cultivated by providing opportunities for community building experiences. These could include events through, for example, disciplinary societies like AIChE, department gatherings including meals, or other events designed to involve students within their engineering or computing department [98].

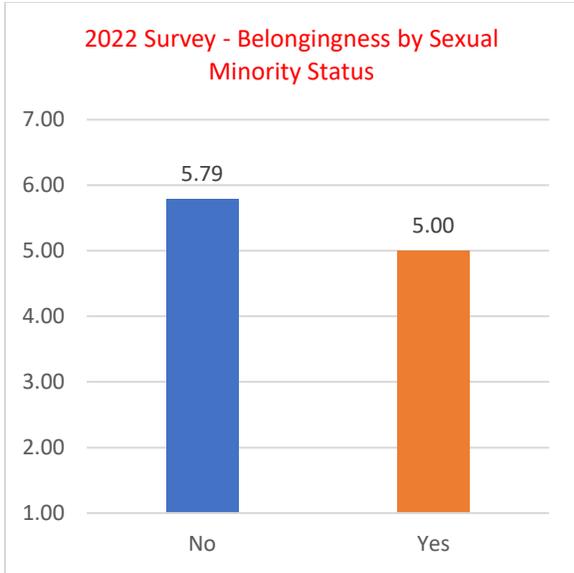
Gender



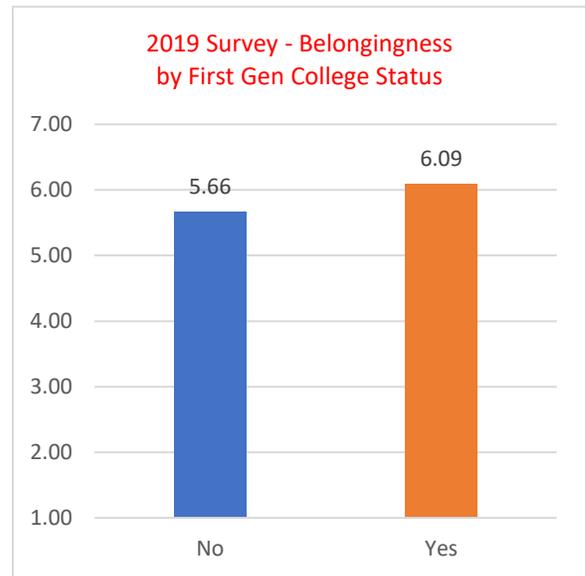
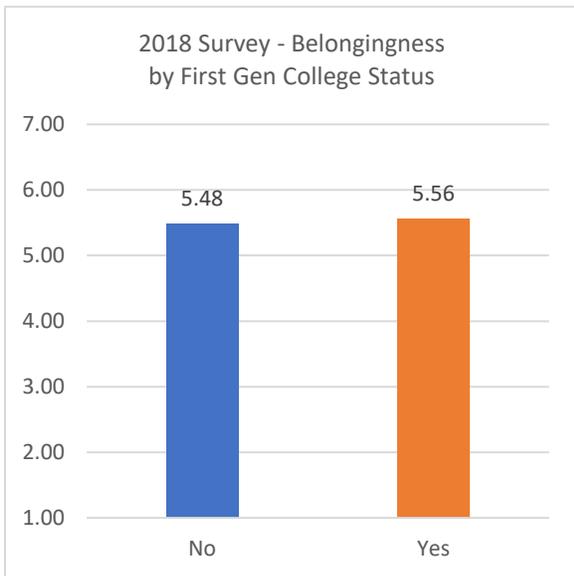


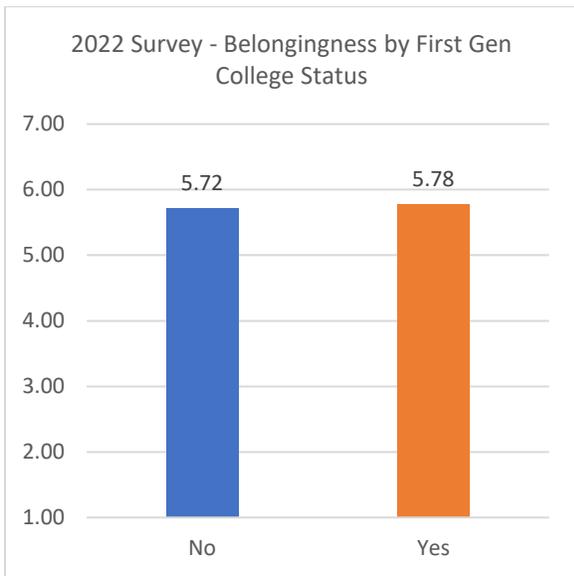
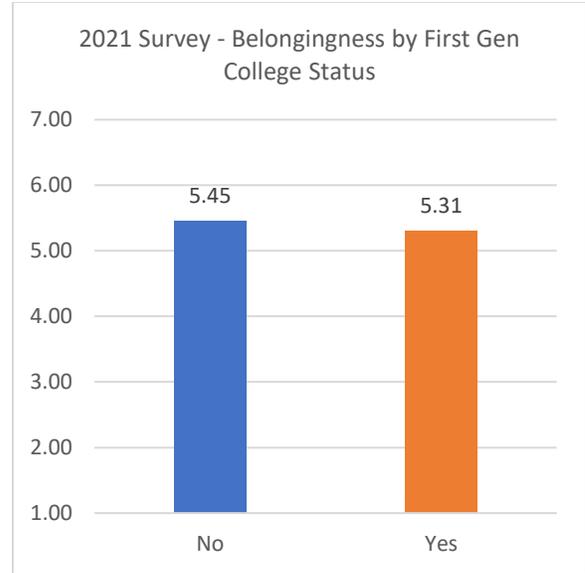
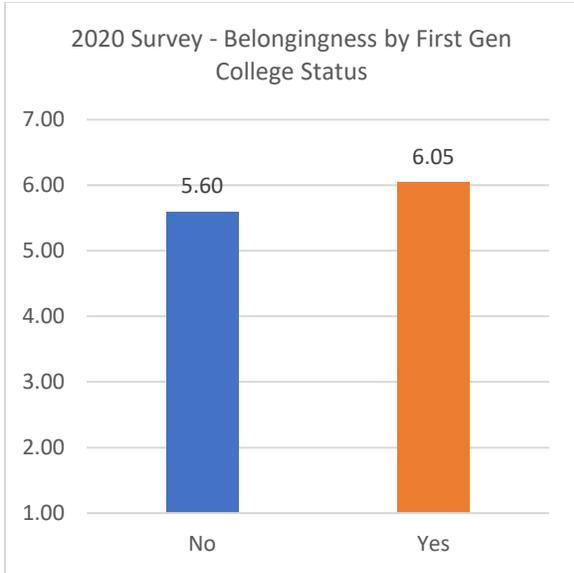
Sexual Minority Status



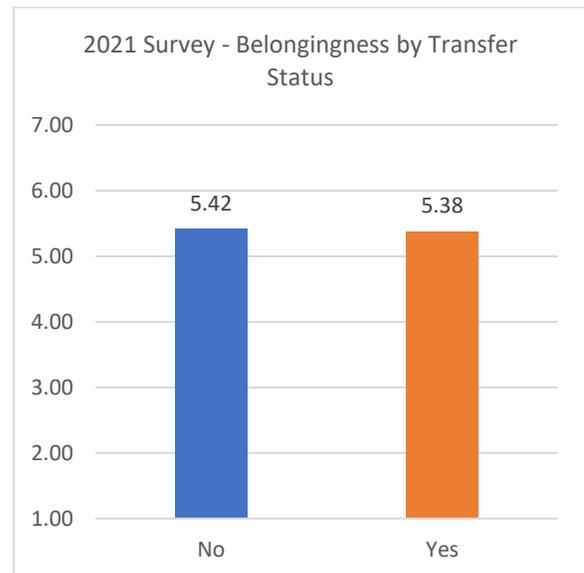
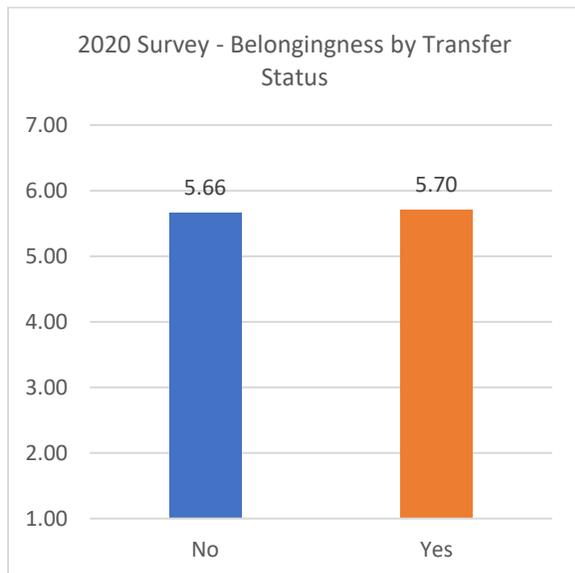
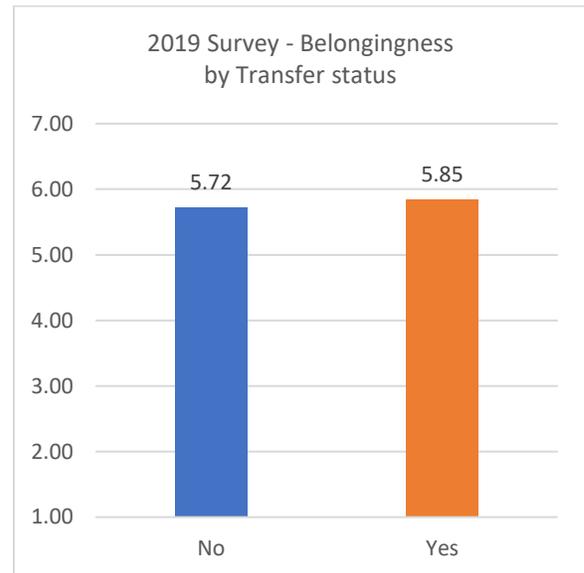
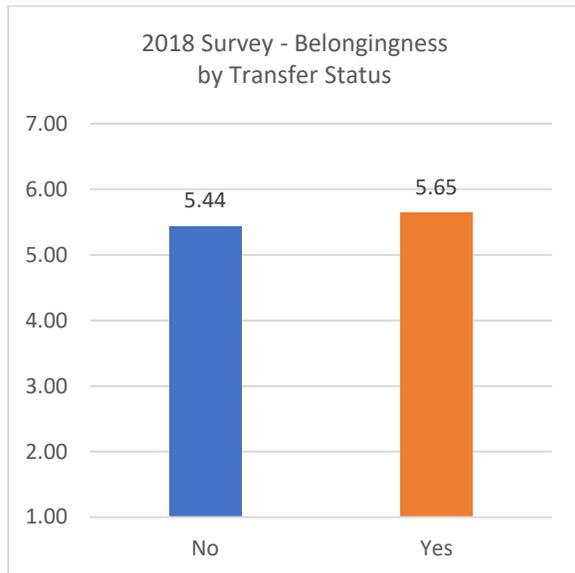


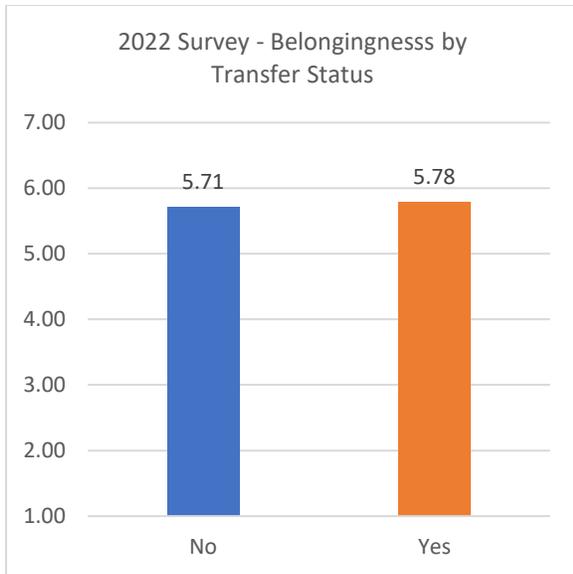
First-generation College Status



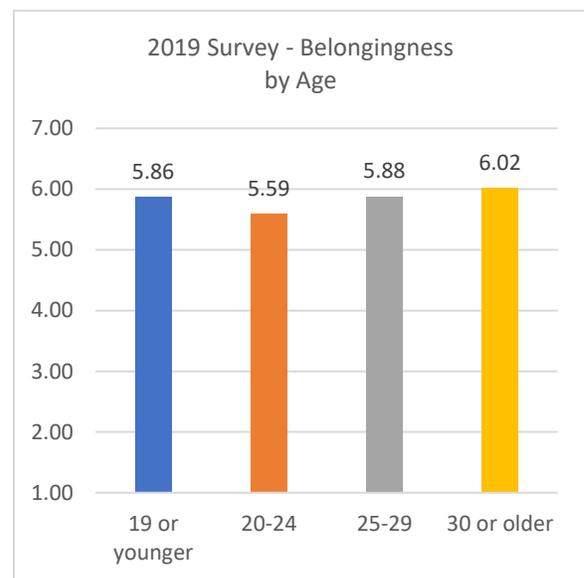
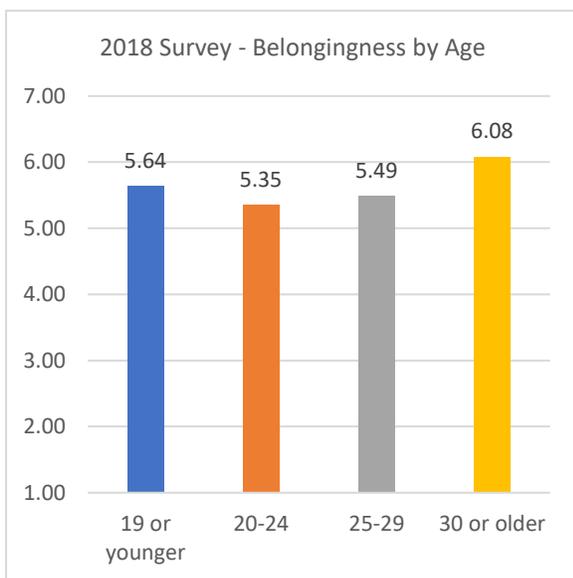


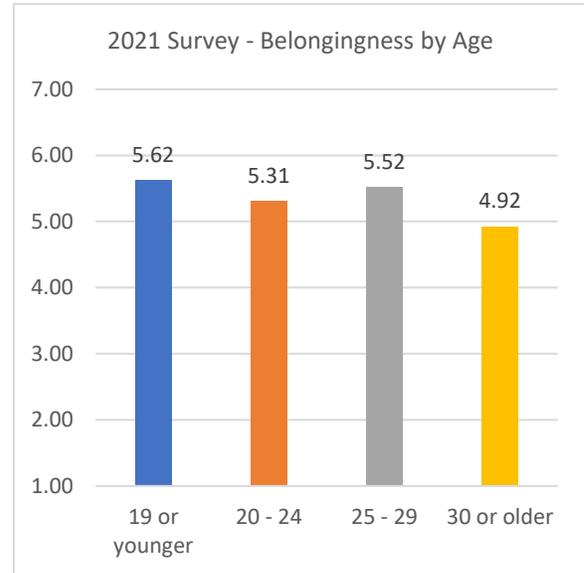
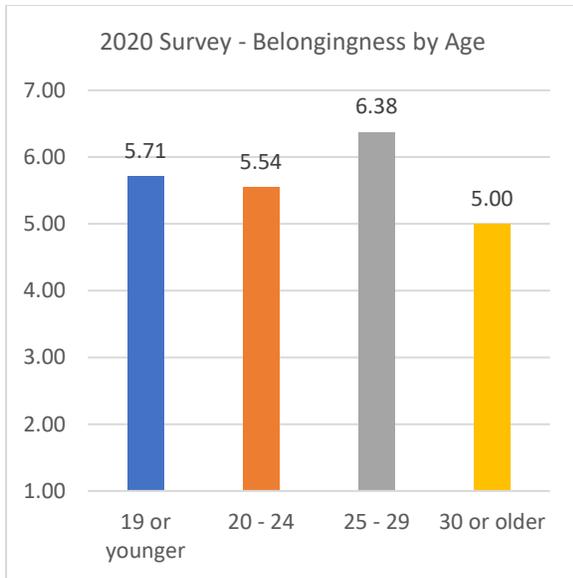
Transfer Status



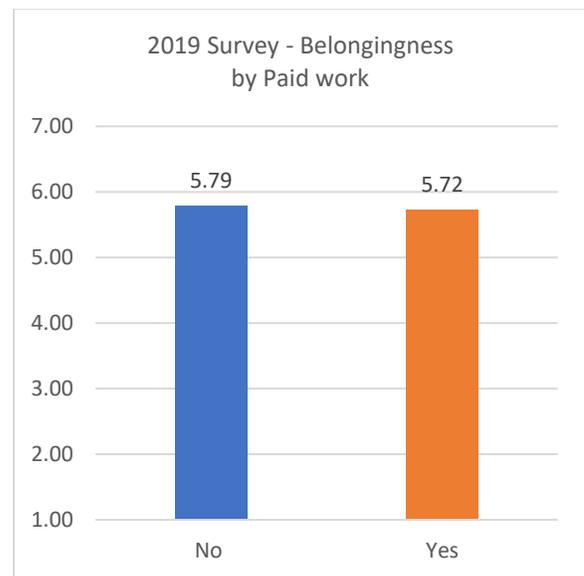
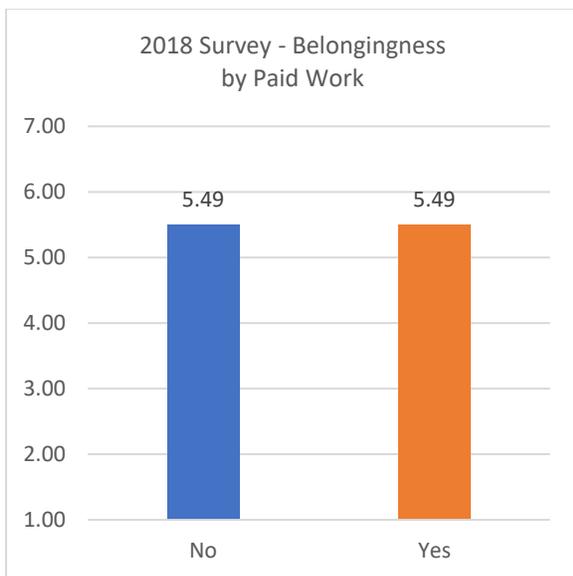


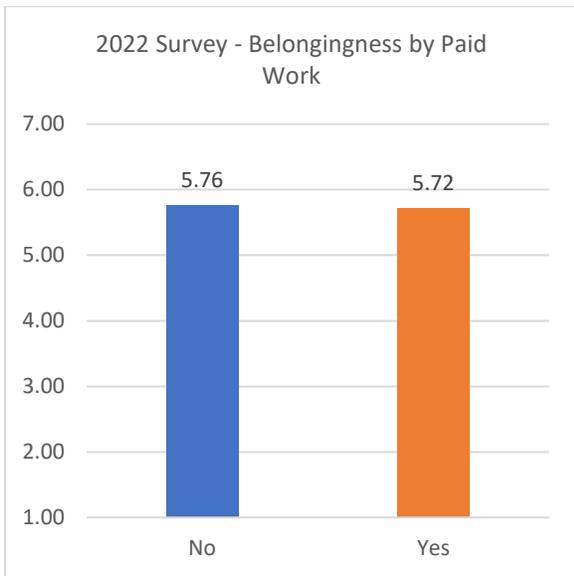
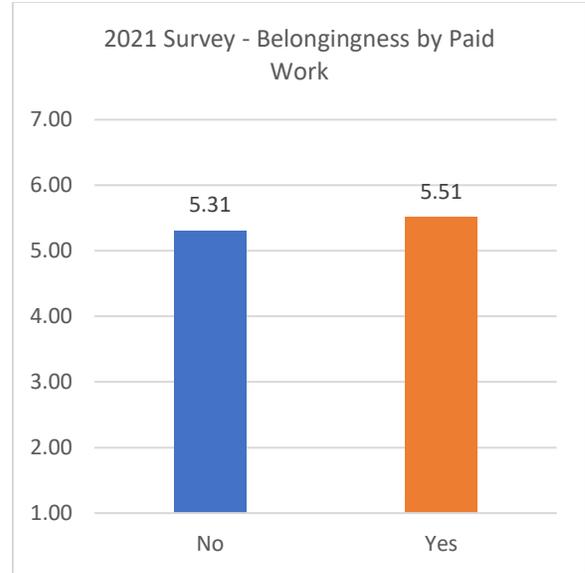
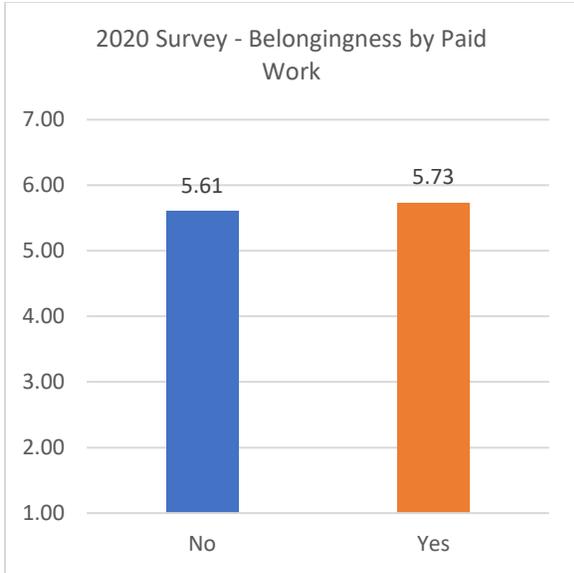
Age





Employment status





Gratitude

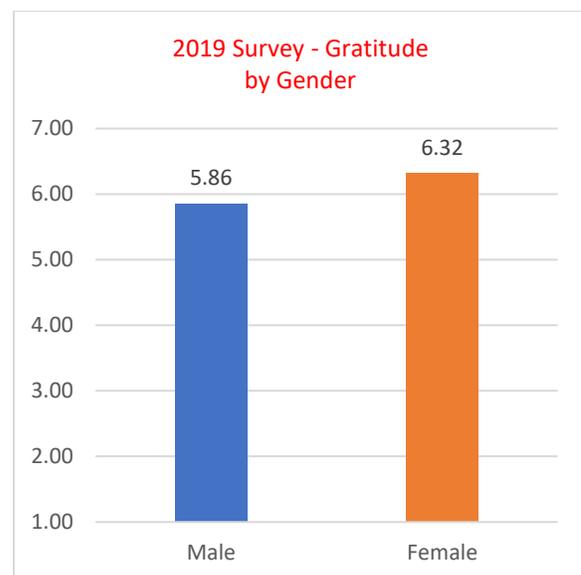
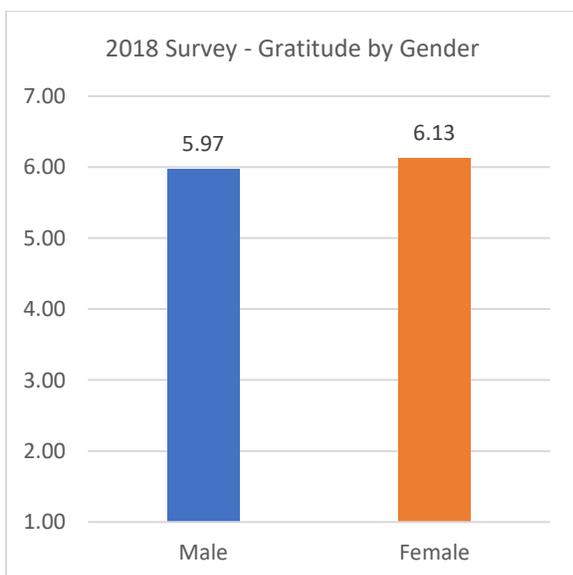
Gratitude consists of feelings of appreciation for someone else in response to receiving benefits that were intentionally provided, especially at some cost to the benefactor [30, 63]. There are both interpersonal and intrapersonal benefits of gratitude. Research suggests gratitude is one of the strongest correlates to emotional wellbeing [97], life satisfaction, optimism, and reduced anxiety [51]. Furthermore, gratitude creates a sense of connectedness [51] and motivates people to altruistically benefit others [64]. The educational benefits of gratitude are manifold, including improved teamwork, more enjoyment in learning, better wellbeing, and increased likelihood of giving back (such as through alumni engagement) [5].

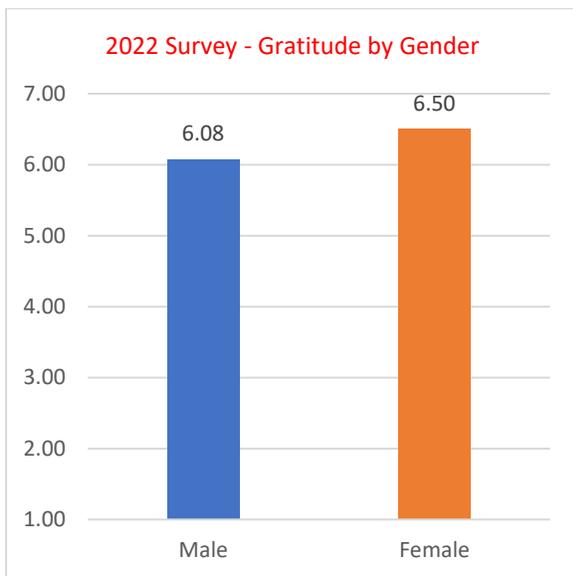
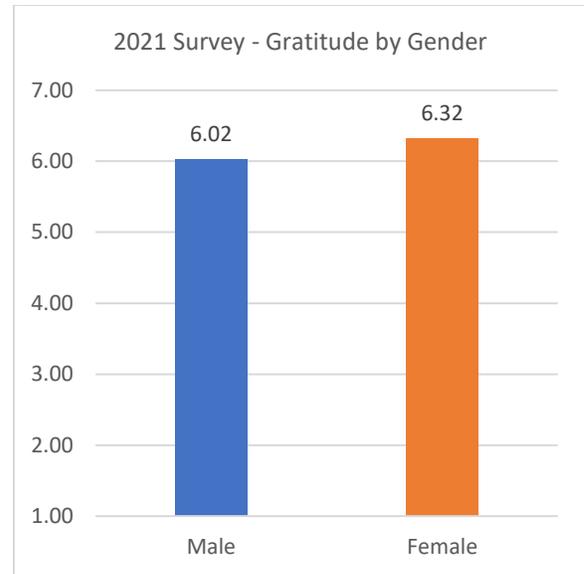
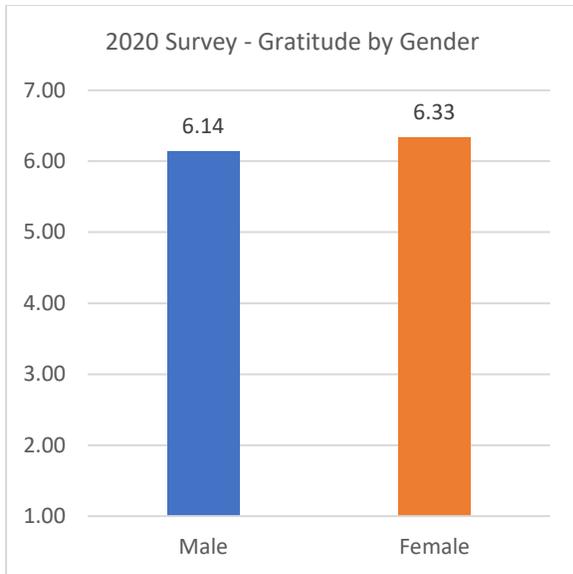
Number of items: 4

Interpretation of the scale: Higher gratitude scores indicate that students experience greater appreciation for other people, resources, opportunities, and their college experiences

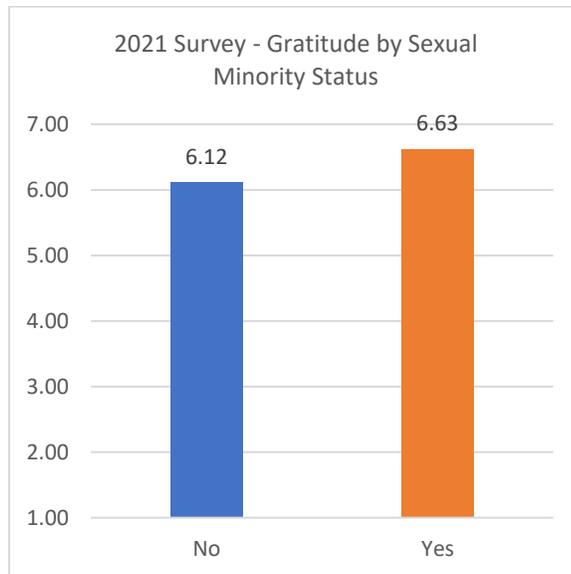
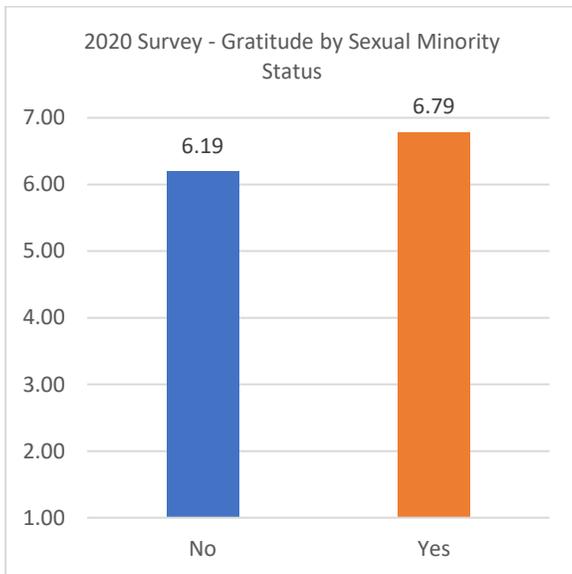
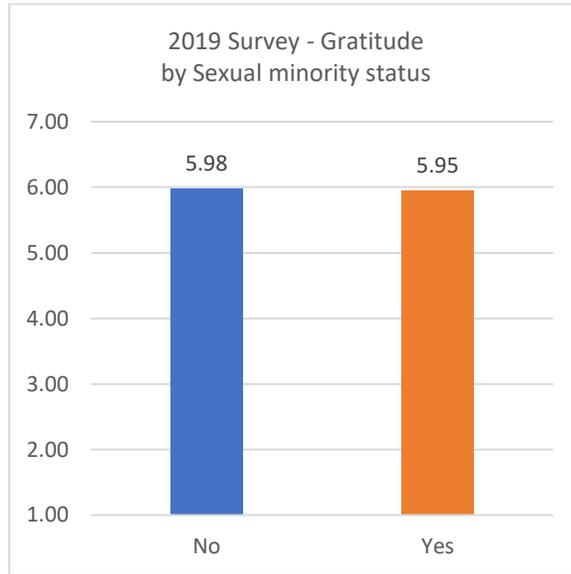
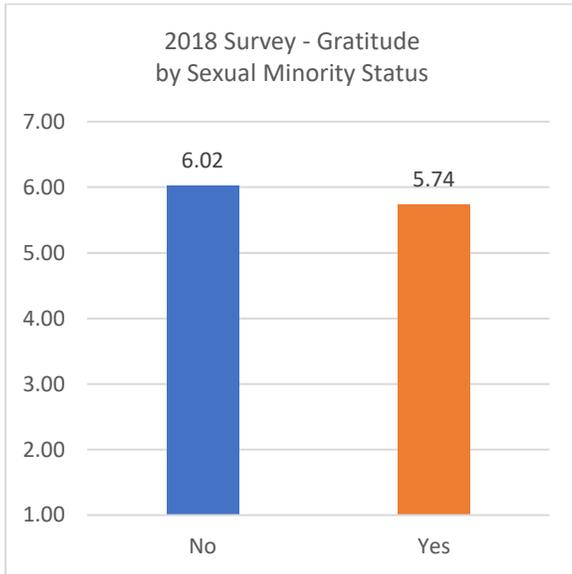
Malleability: Research shows that we can increase feelings of gratitude as well as grateful behaviors (such as expressing gratitude) through low-cost, quick interventions. Some interventions that cultivate gratitude include keeping a gratitude journal by listing things for which we are grateful, writing letters of gratitude for someone else, and learning about gratitude (both personal and interpersonal benefits) in classroom settings [51, 31, 58, 15].

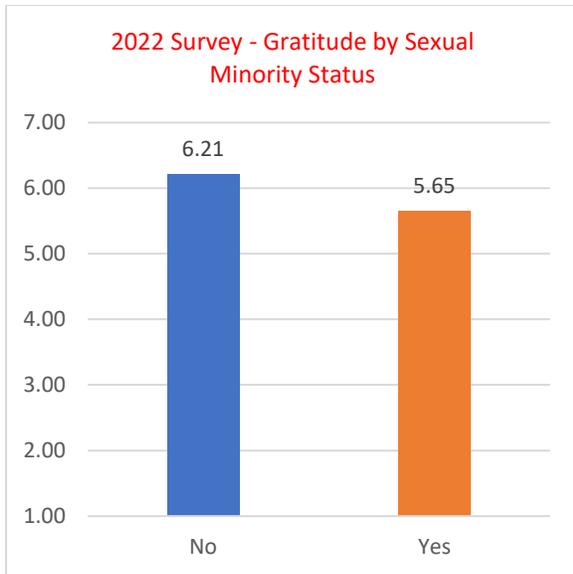
Gender



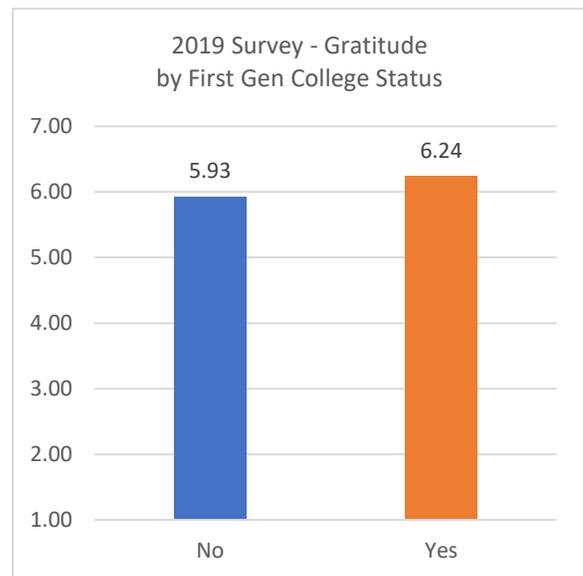
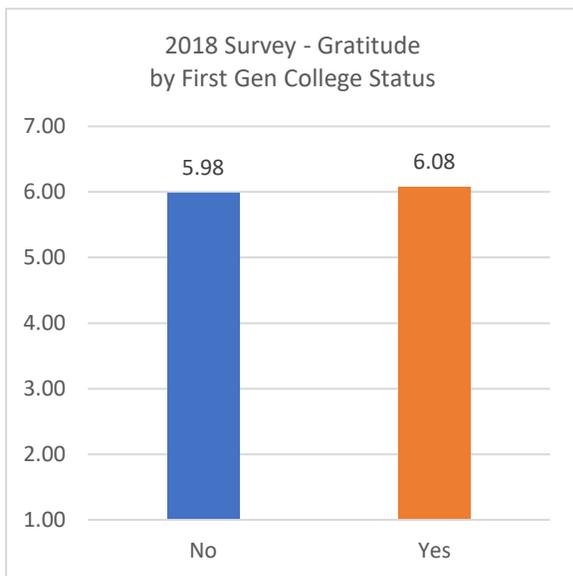


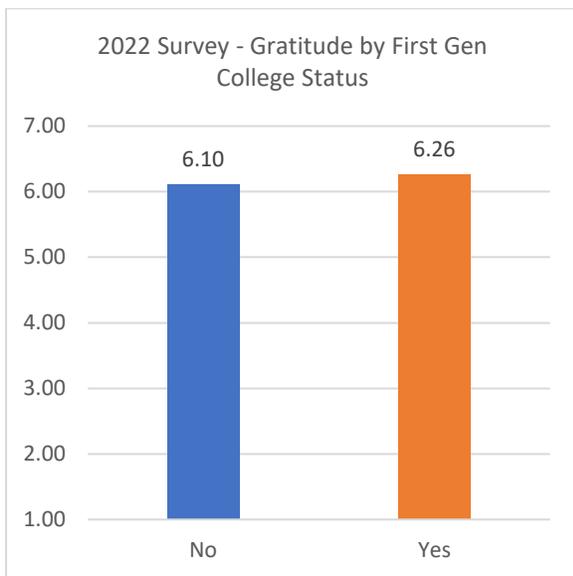
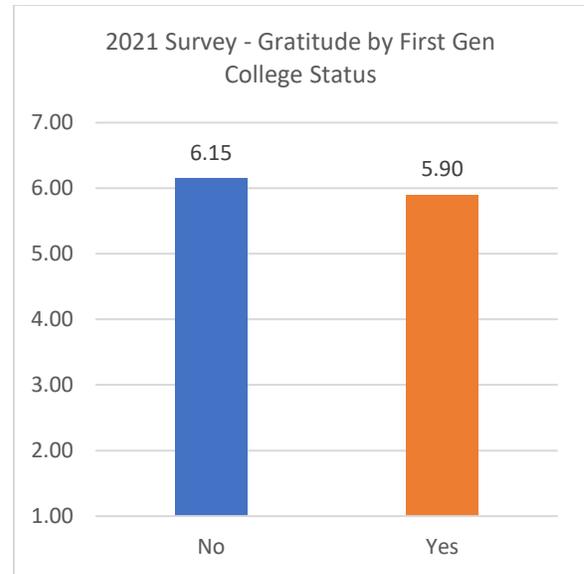
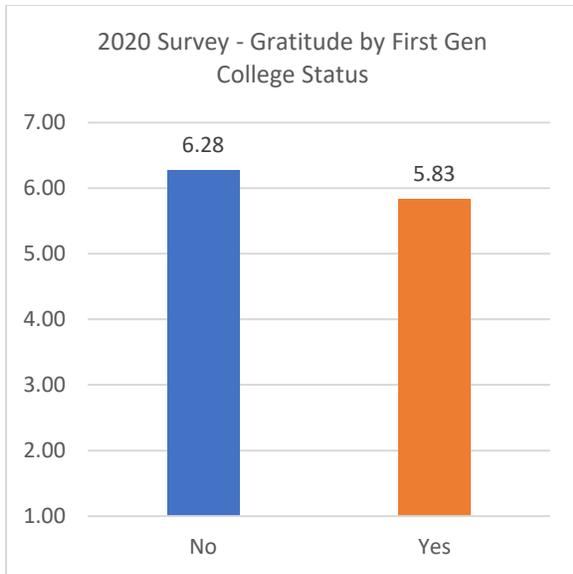
Sexual Minority Status



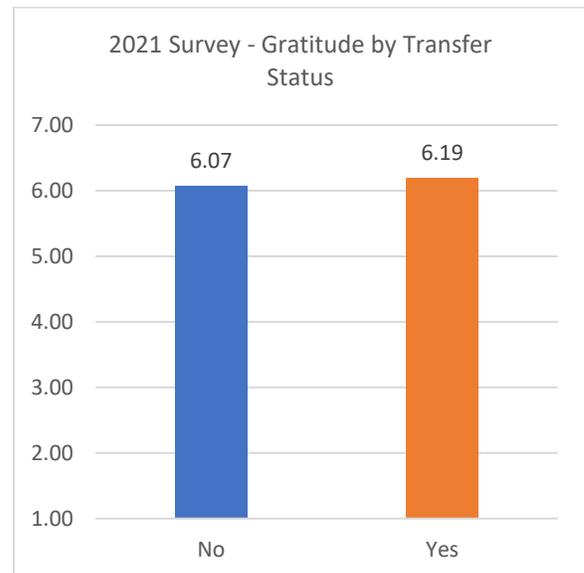
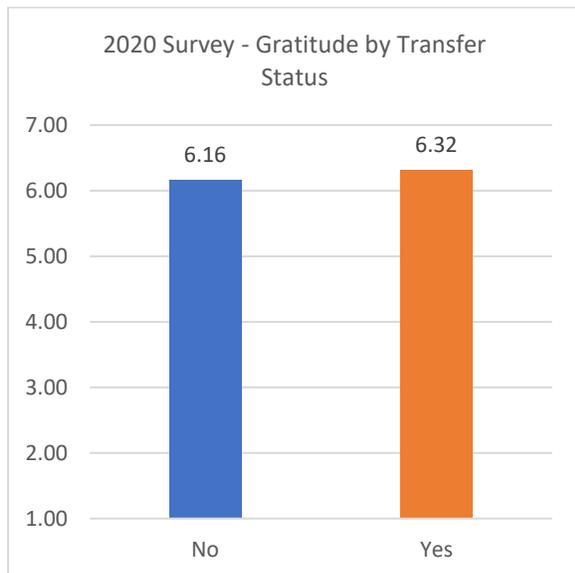
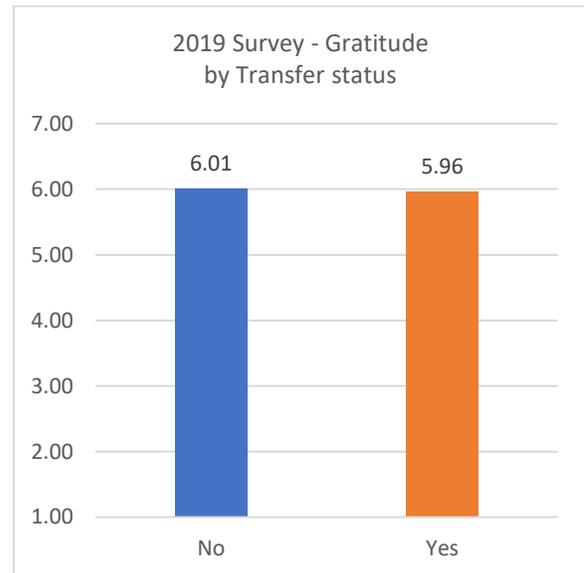
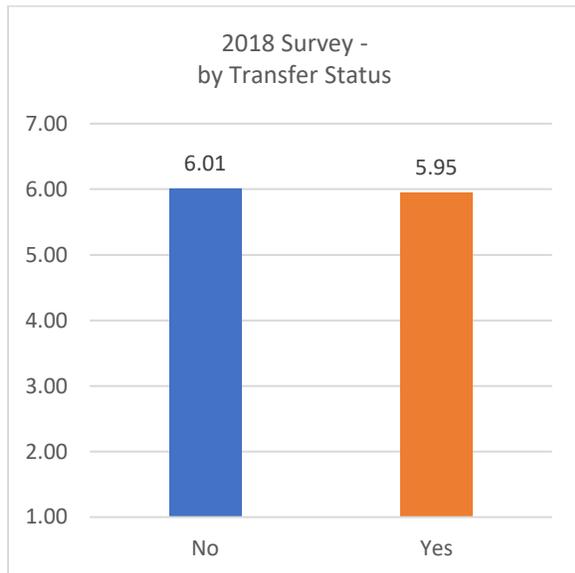


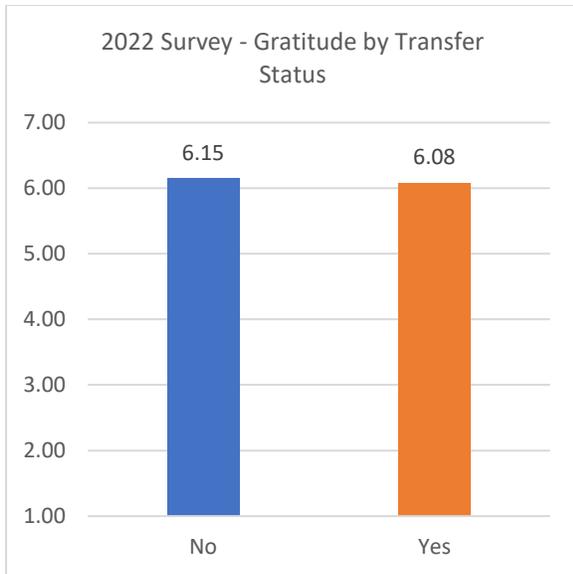
First-generation College Status



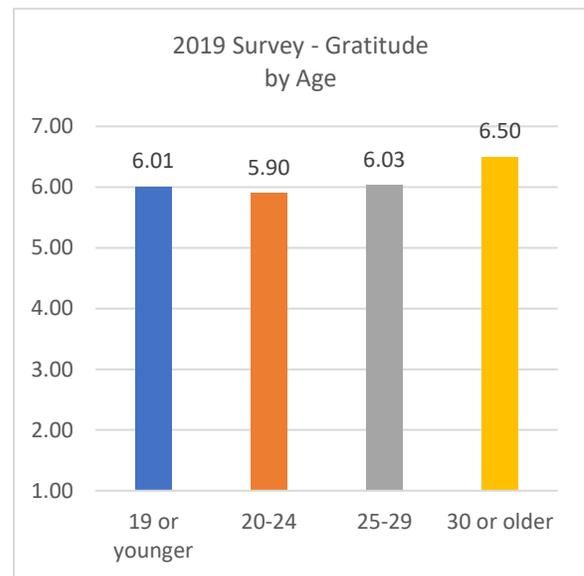
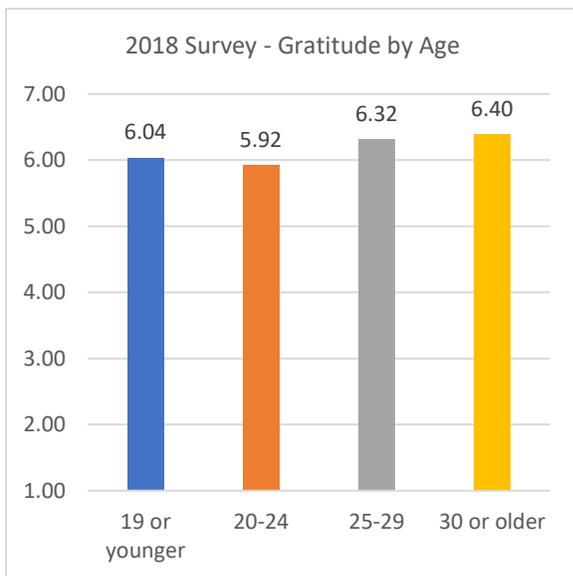


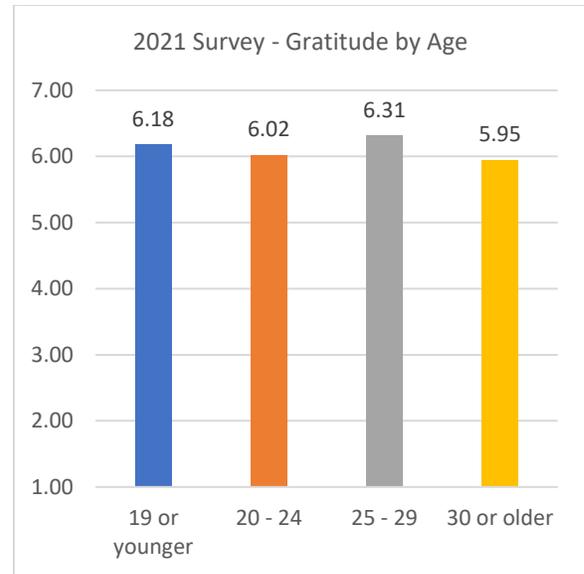
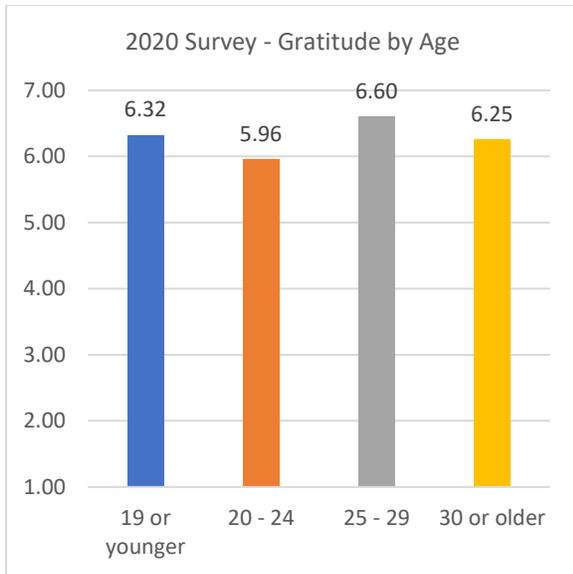
Transfer Status



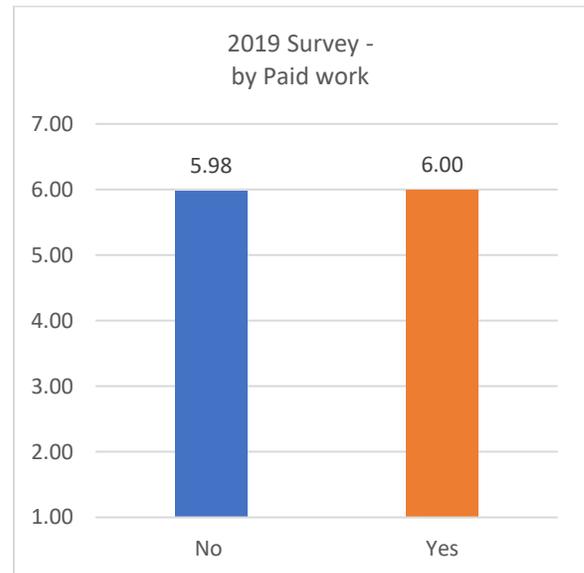
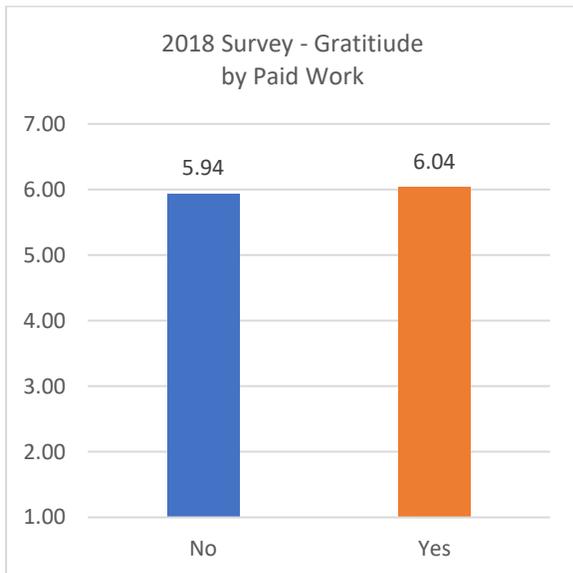


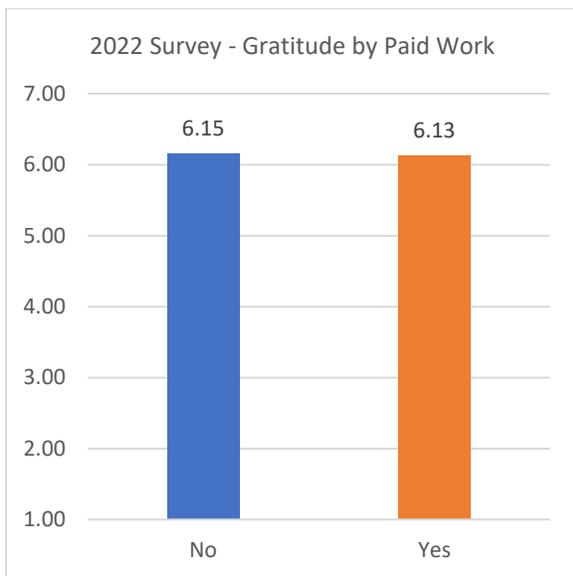
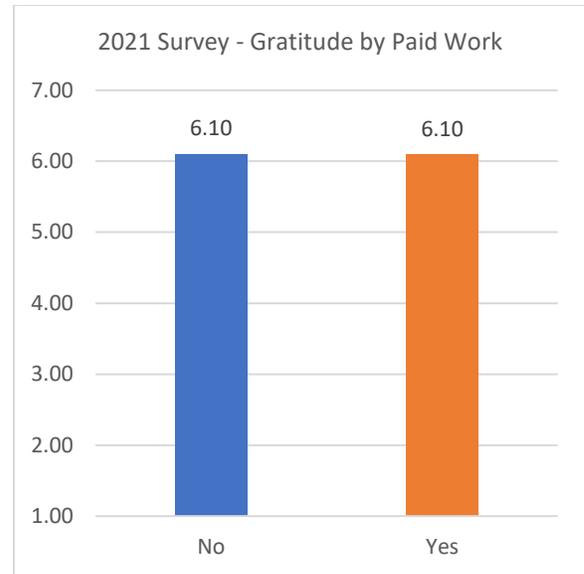
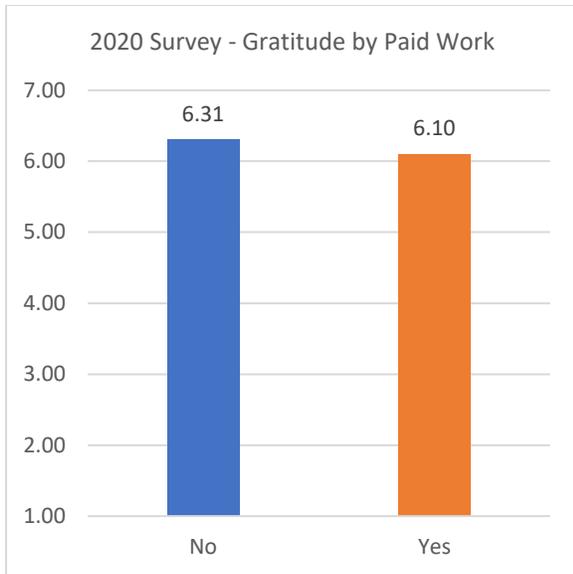
Age





Employment status





Future Time Perspective (Motivation)

We utilized a Future Time Perspective approach to measure students' motivation. This perspective examines motivation based on how students formulate distant motivational goals and develop long-range behaviors to achieve those goals. Motivation was measured as five constructs: expectancy (belief one will do well in their endeavors); connectedness (tying current tasks to future goals); instrumentality (current tasks are useful for my emerging identity as an engineering or computing professional); value (value of future goals over present goals); and perceptions of future (domain specific valuing of the future).

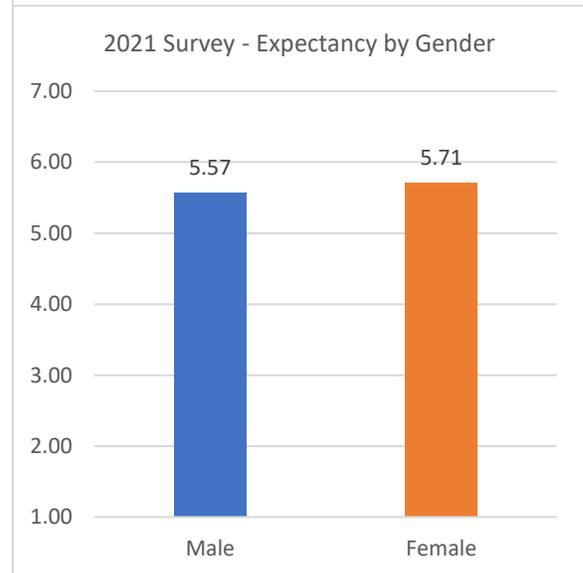
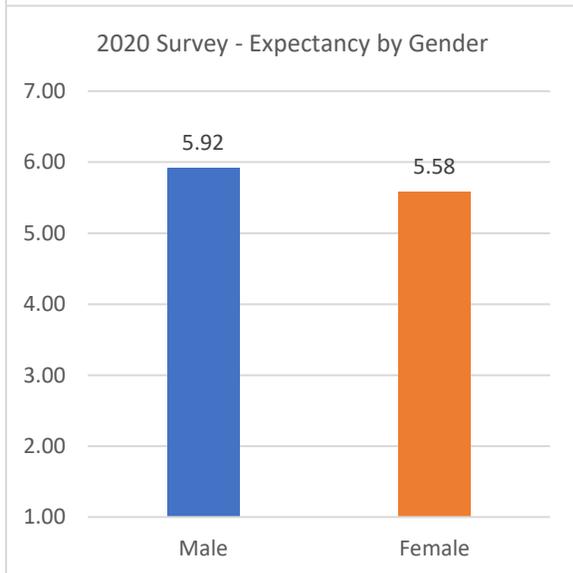
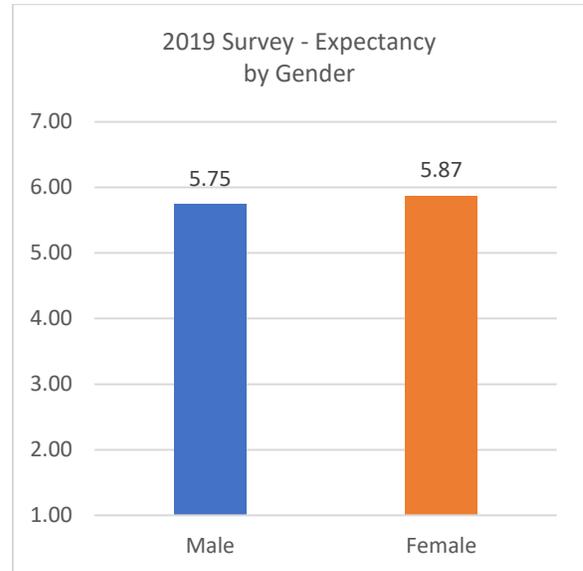
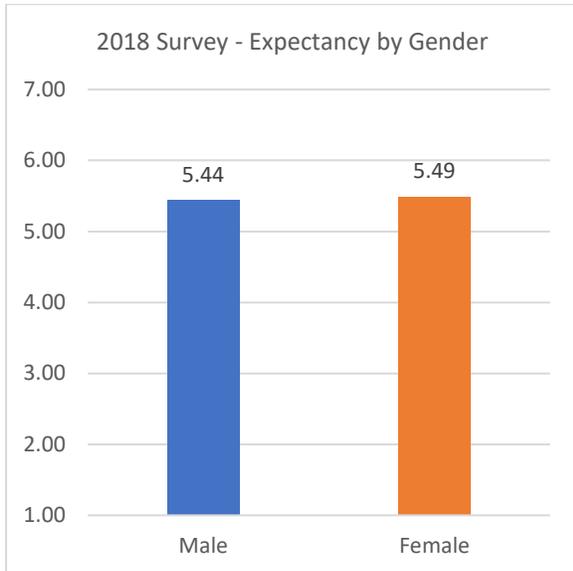
Number of items: 18

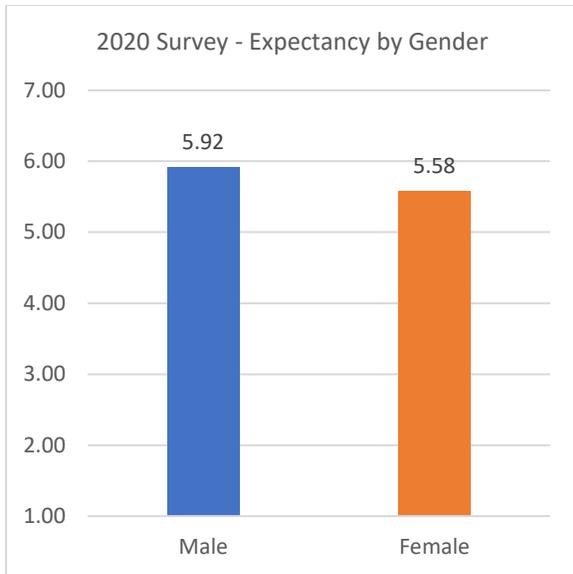
Interpretation of the scale: Higher scores indicate that students experience more motivation in the various dimensions of motivation measured

Malleability: Motivation can be fostered in students by tying current coursework and actions to future goals, encouraging students to believe in their ability to succeed, and explaining the value of course topics for students. For example, instructors can provide students with tasks that can be accomplished and explicitly teach students how to create and utilize sub-goals when confronted with difficult tasks [79]. They can also inform students that stress is normal as skills are developing and train students to interpret these frustrations as a form of feedback for progress [79, 3]. Instructors can also ensure that assessment matches the desired and professed learning outcomes of a course so students can self-assess progress [79].

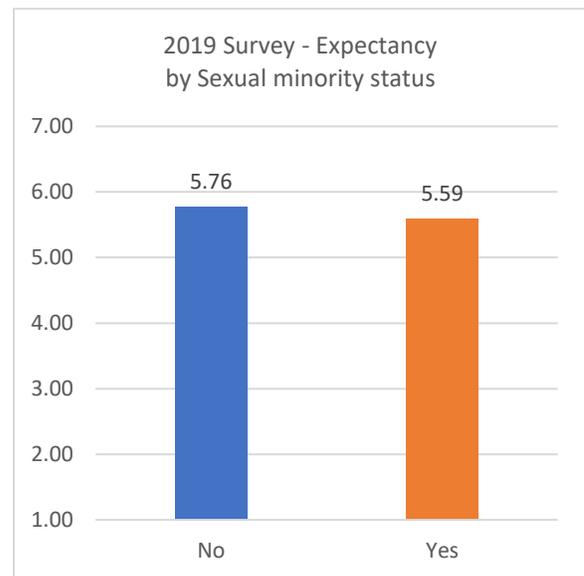
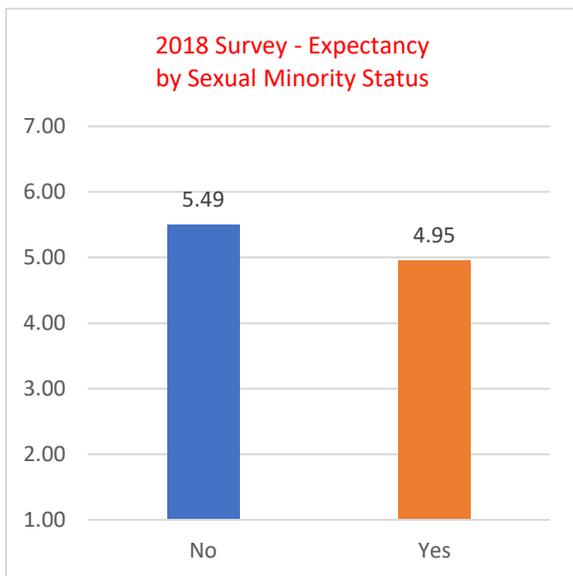
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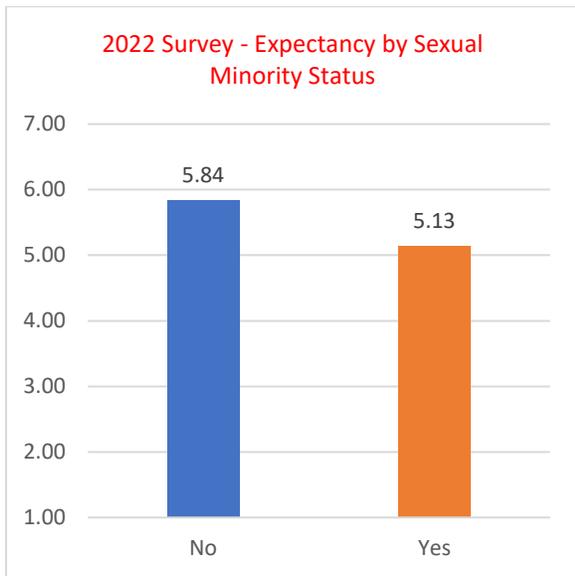
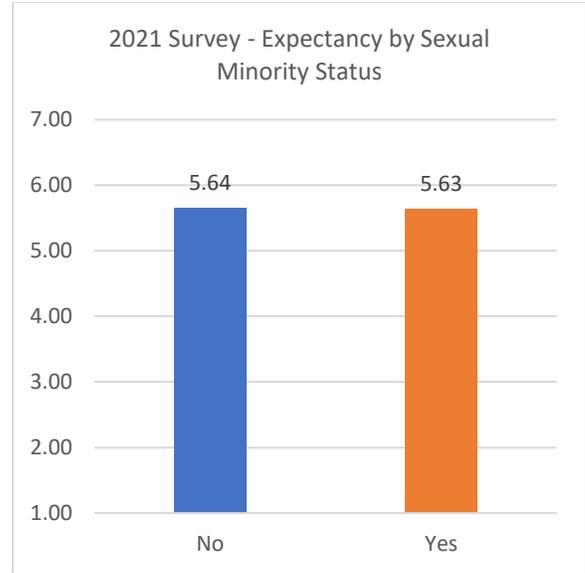
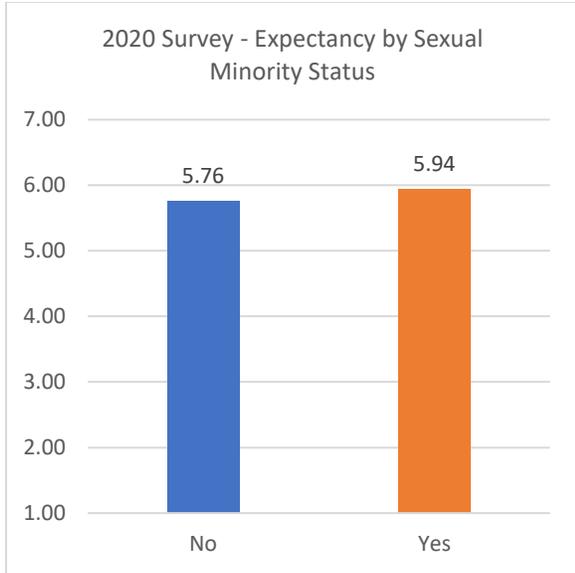
Gender



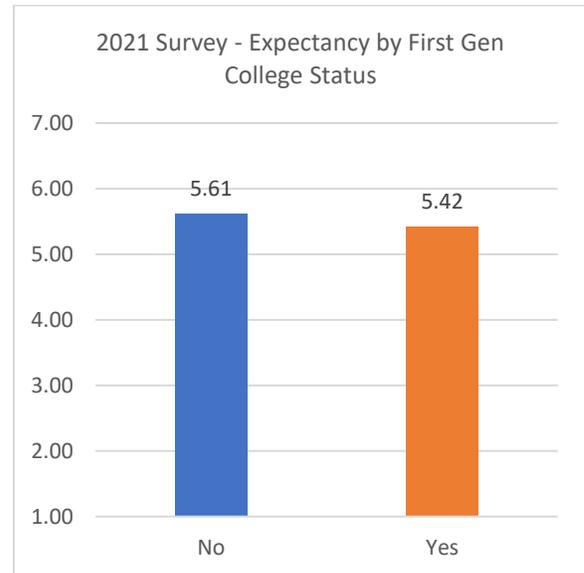
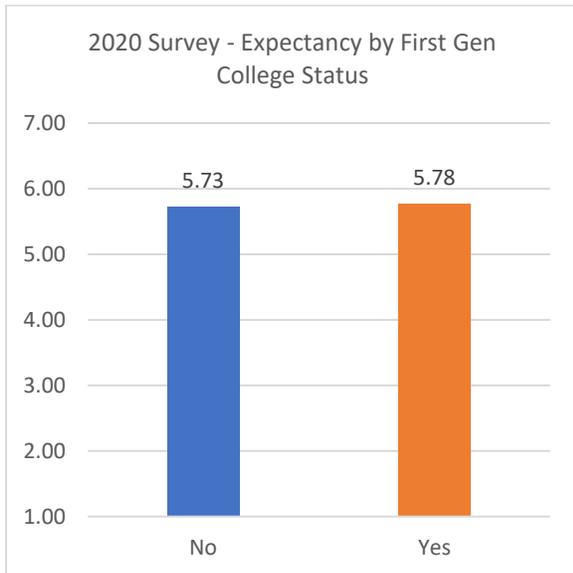
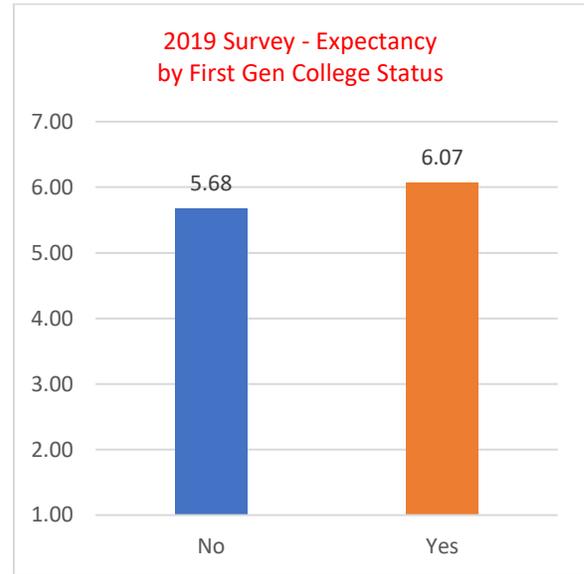
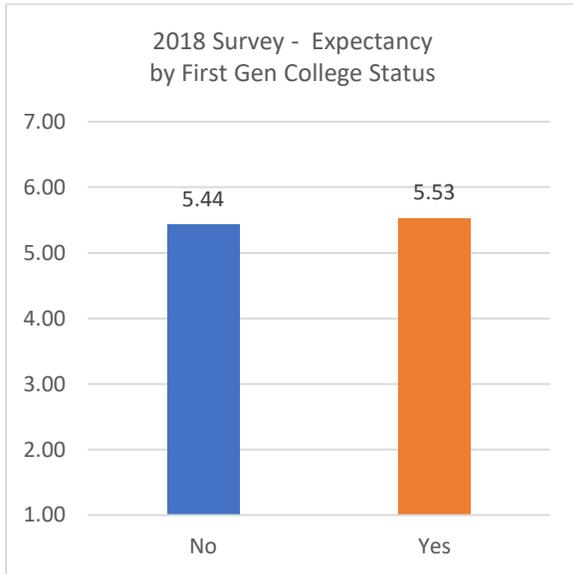


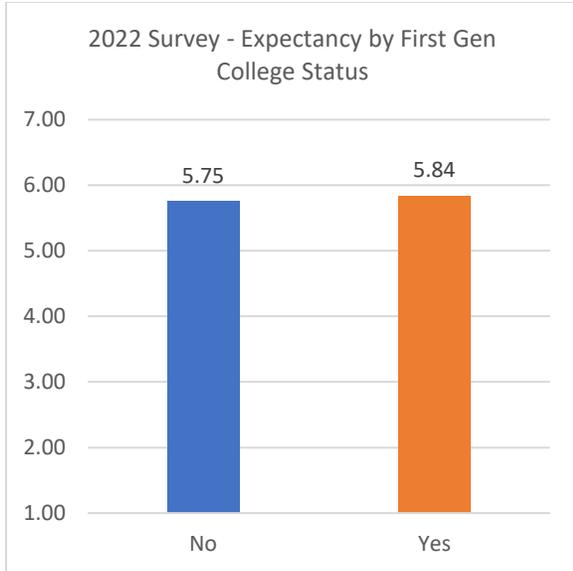
Sexual Minority Status



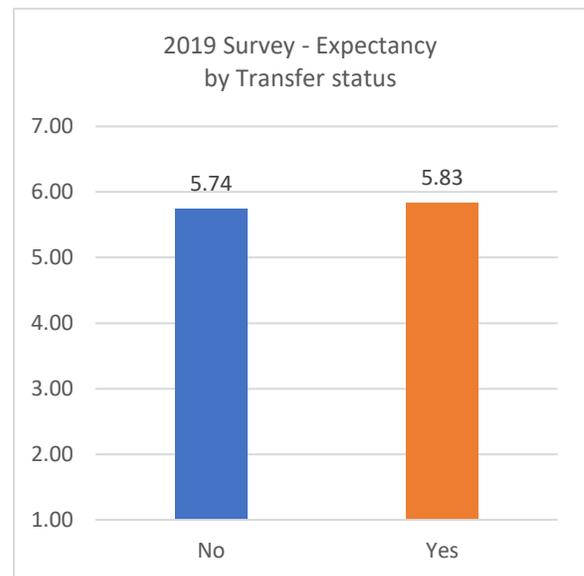
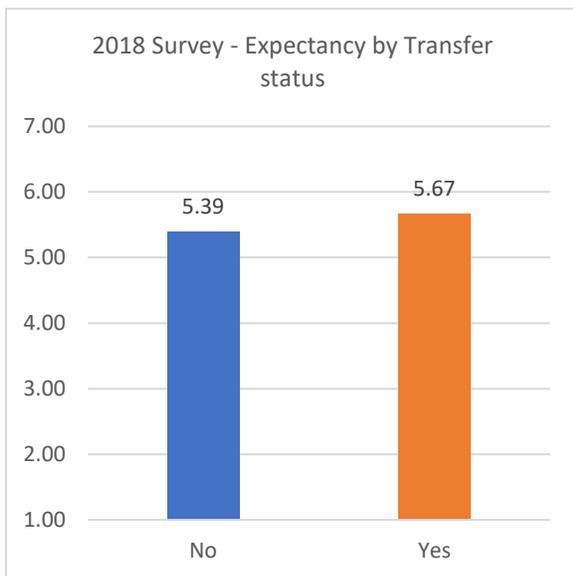


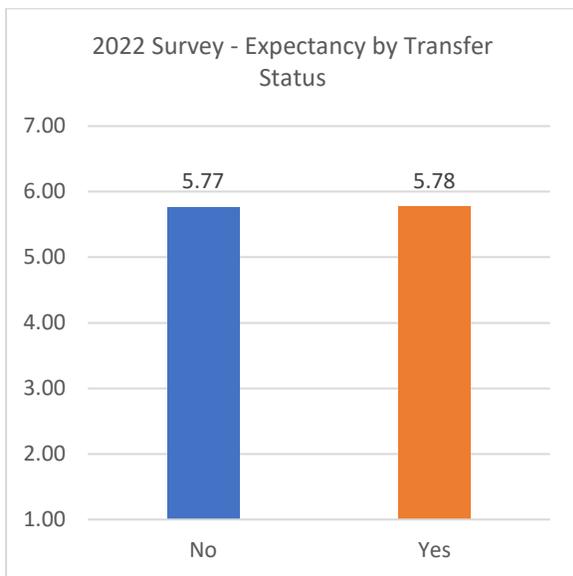
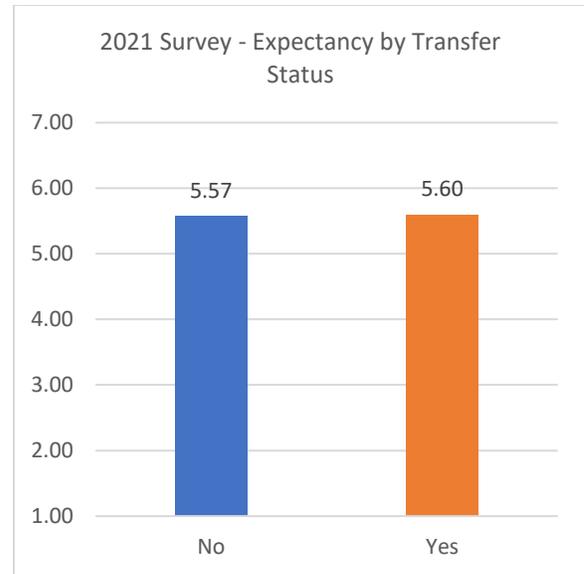
First-generation College Status



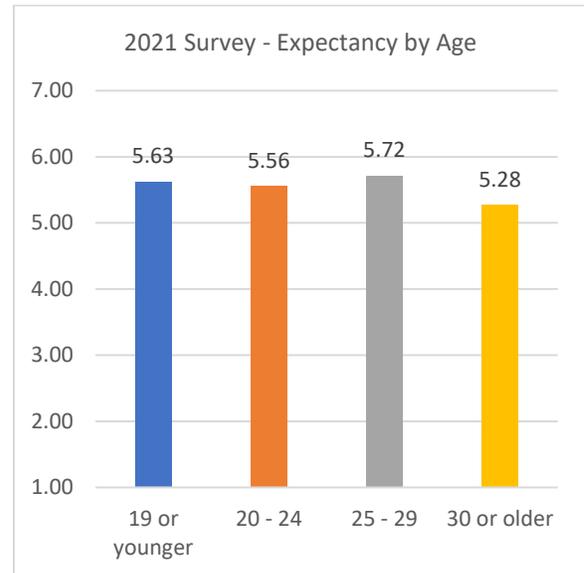
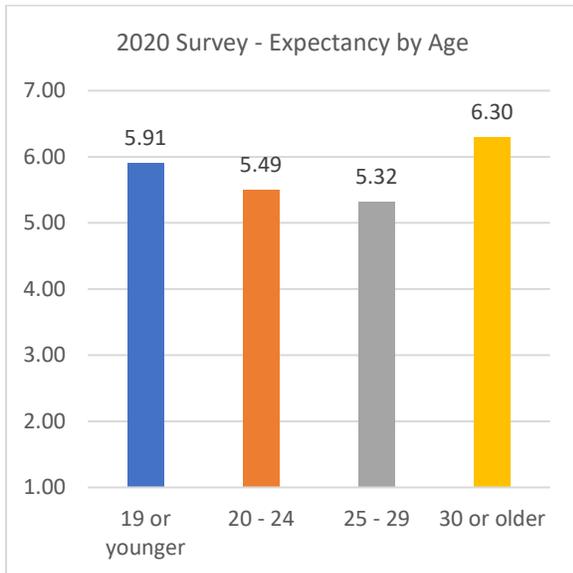
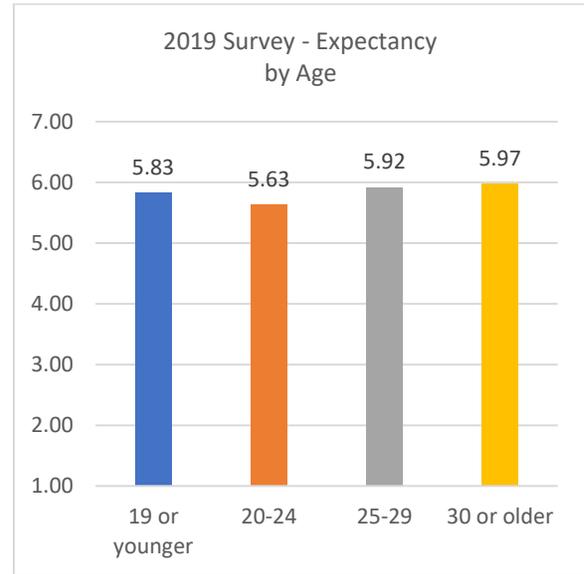
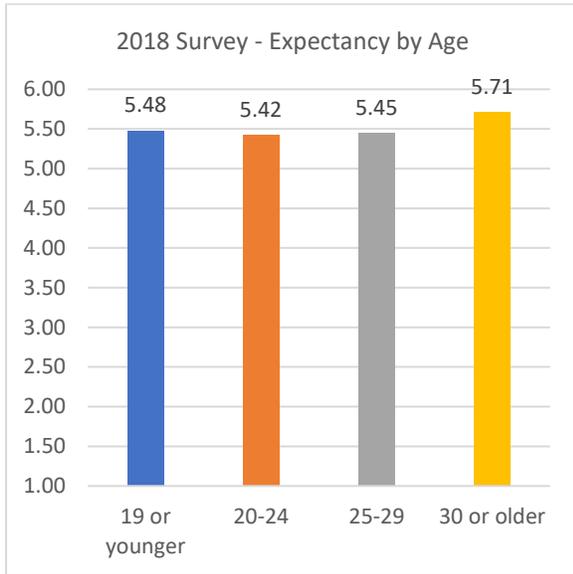


Transfer Status

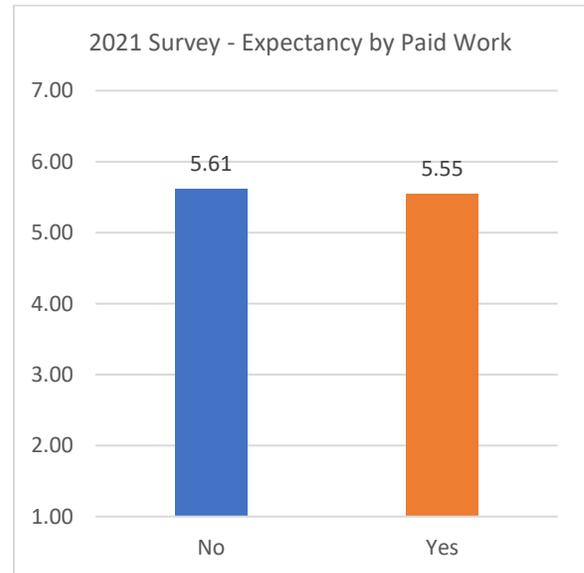
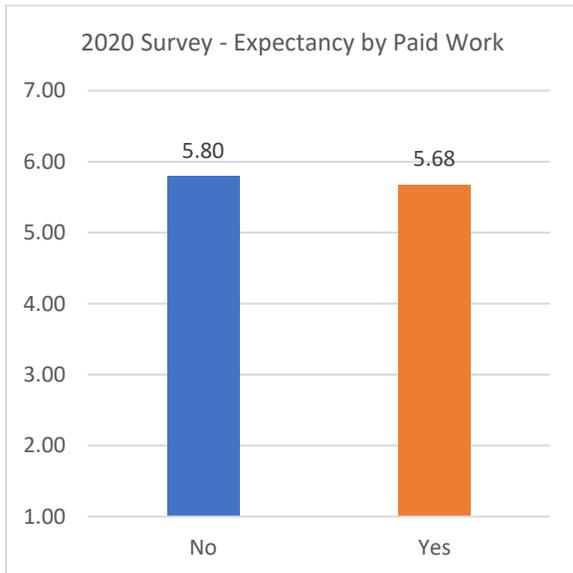
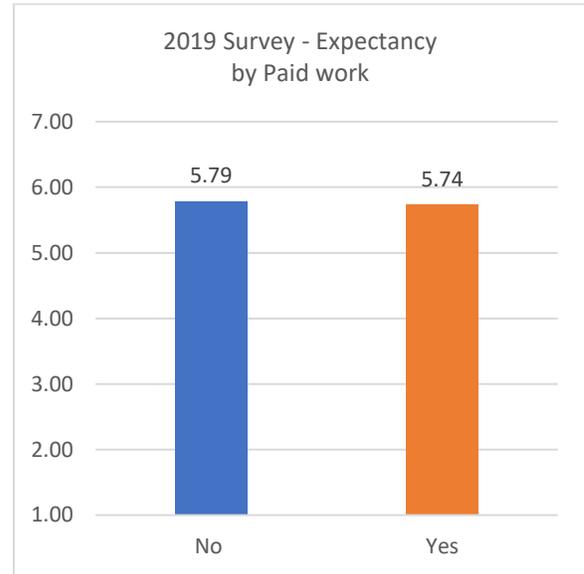
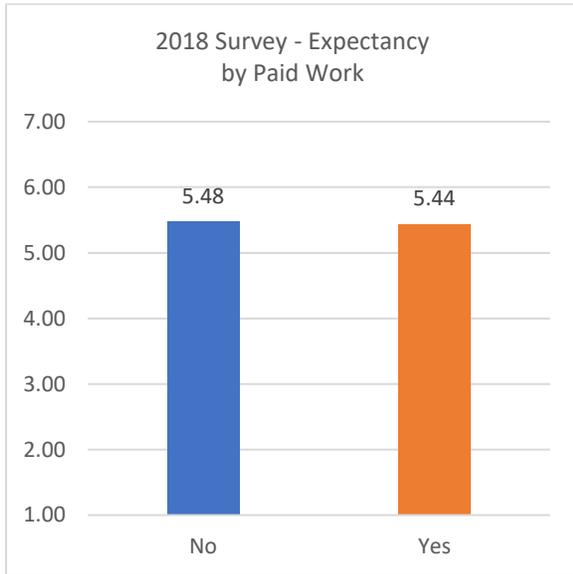


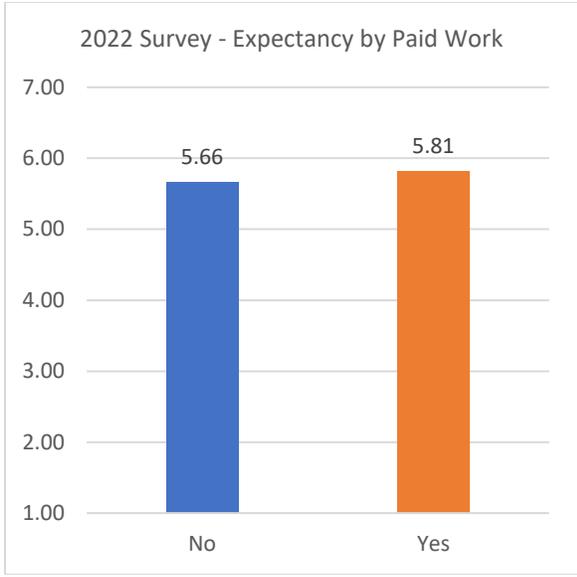


Age



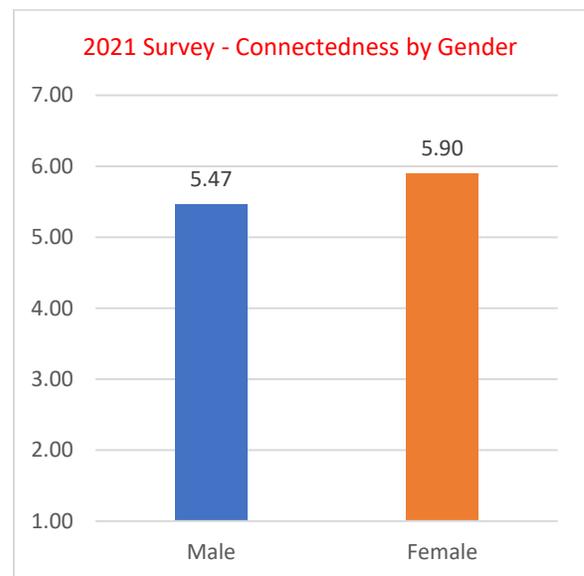
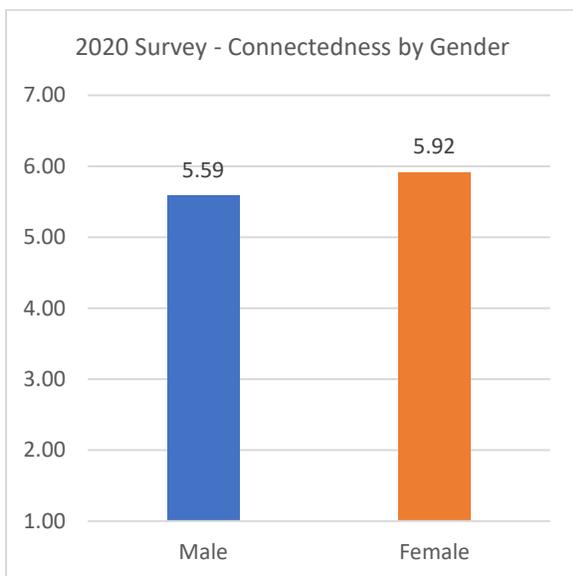
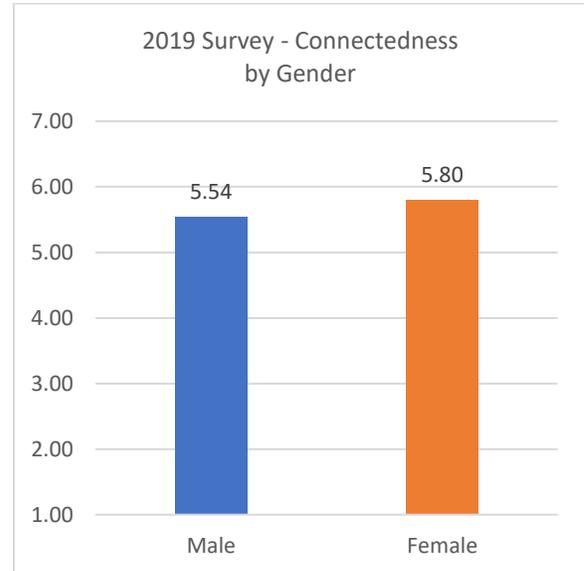
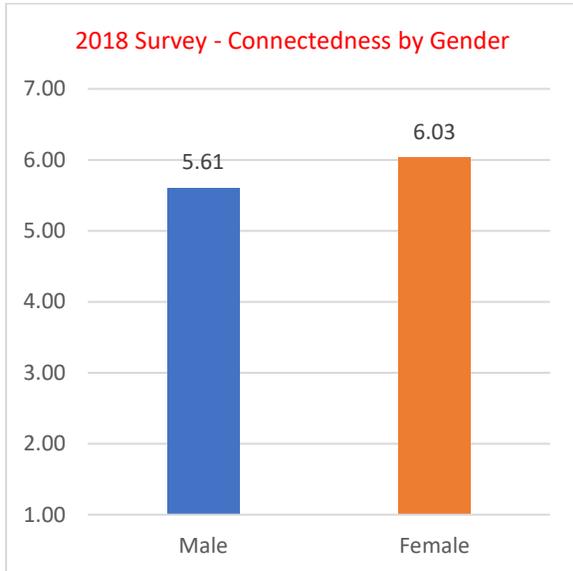
Employment status

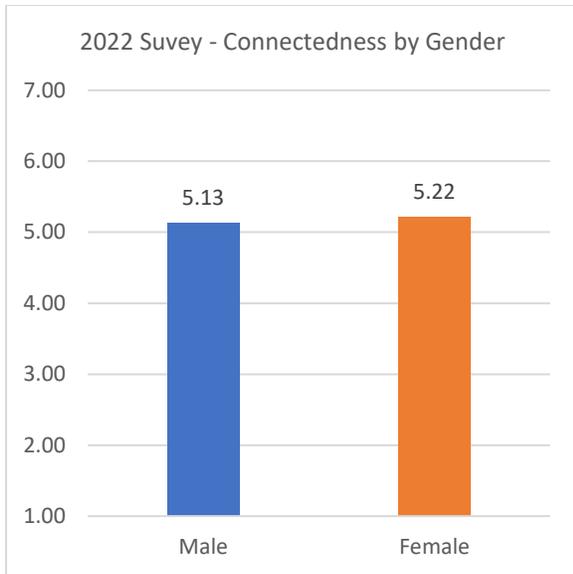




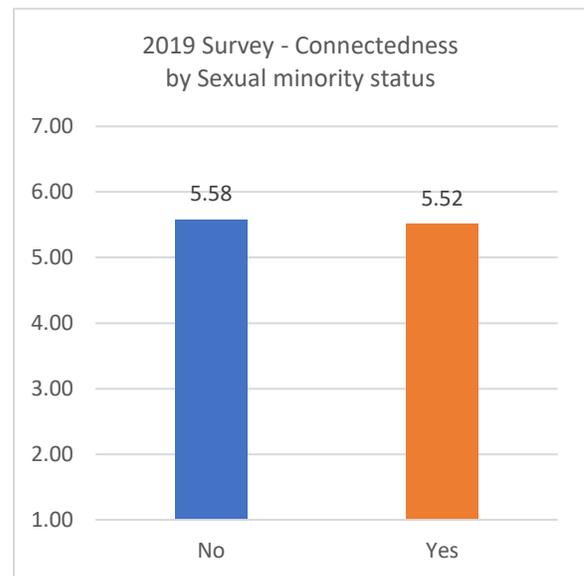
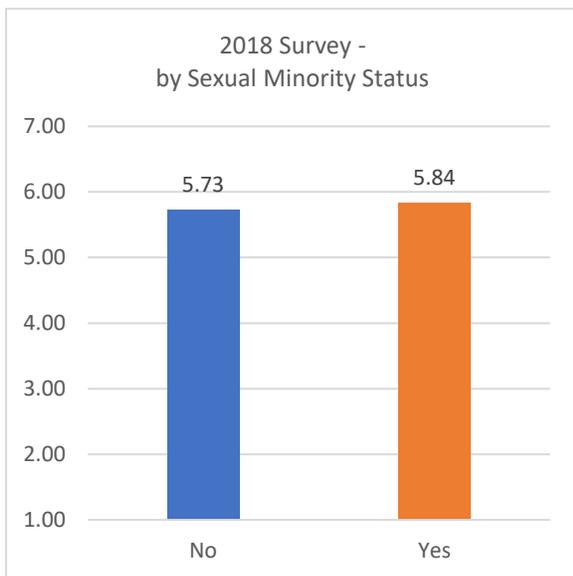
2) Connectedness

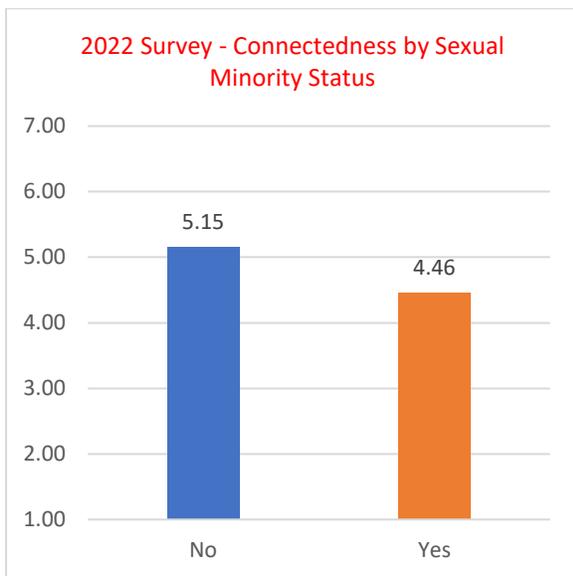
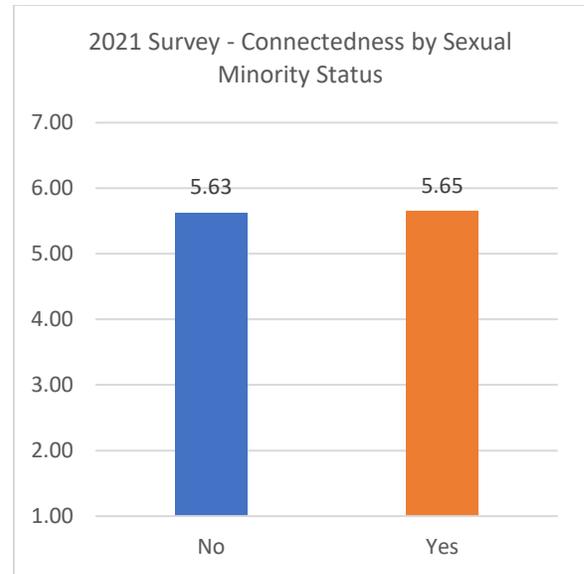
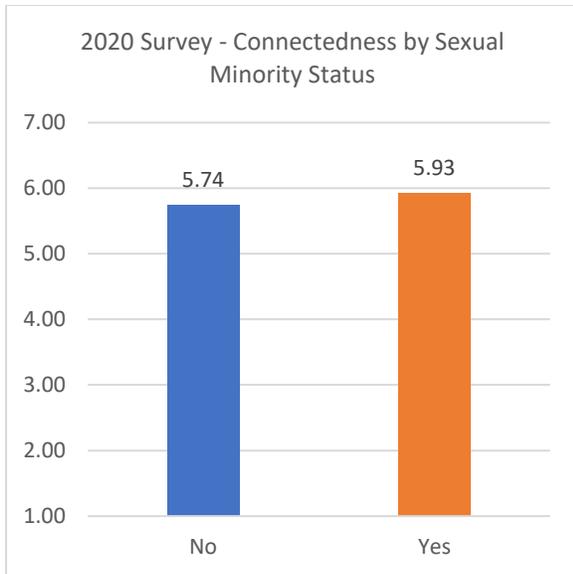
Gender



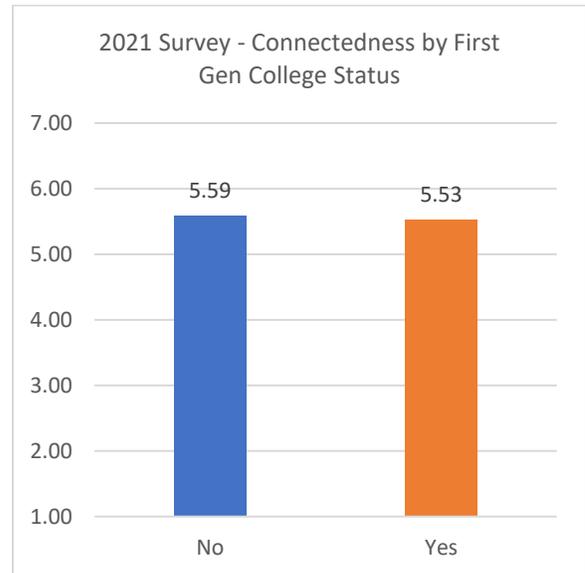
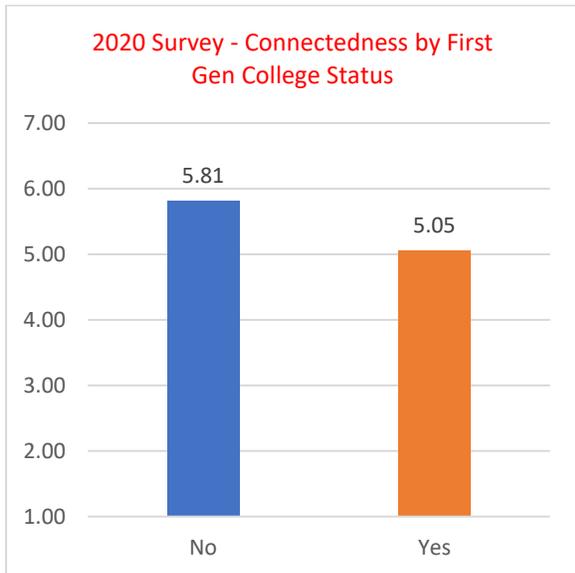
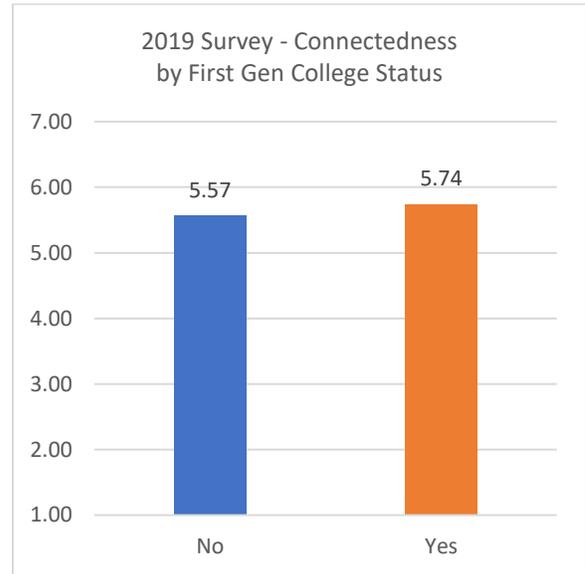
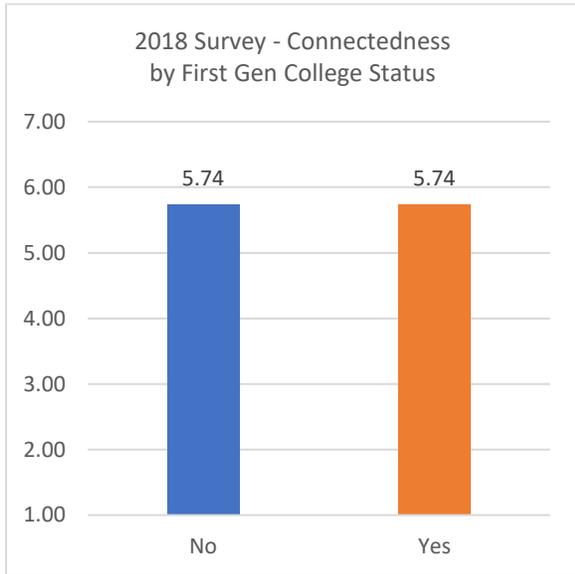


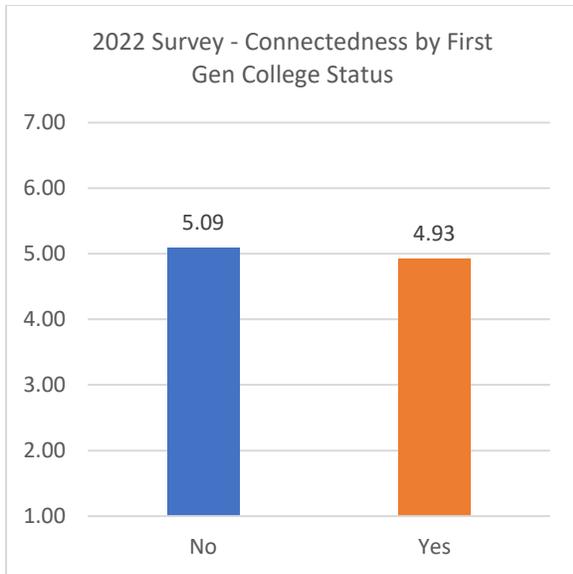
Sexual Minority Status



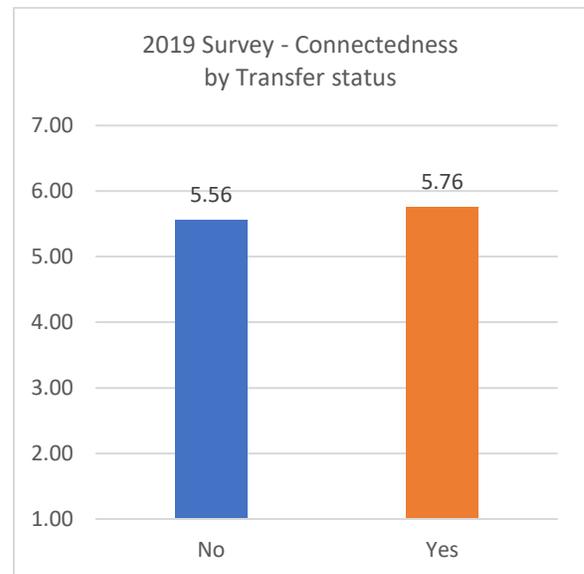
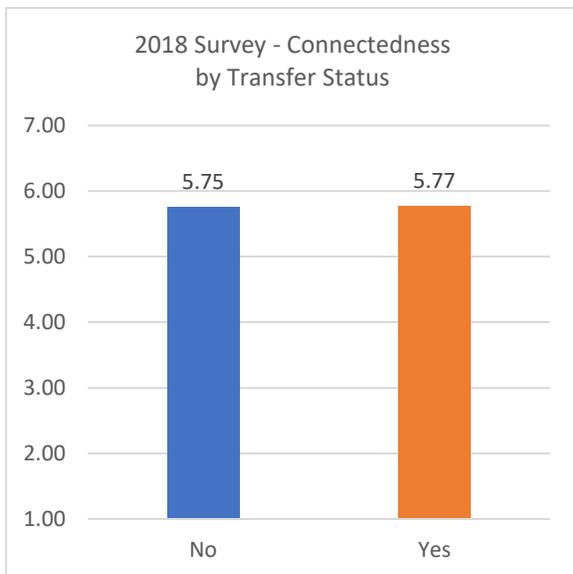


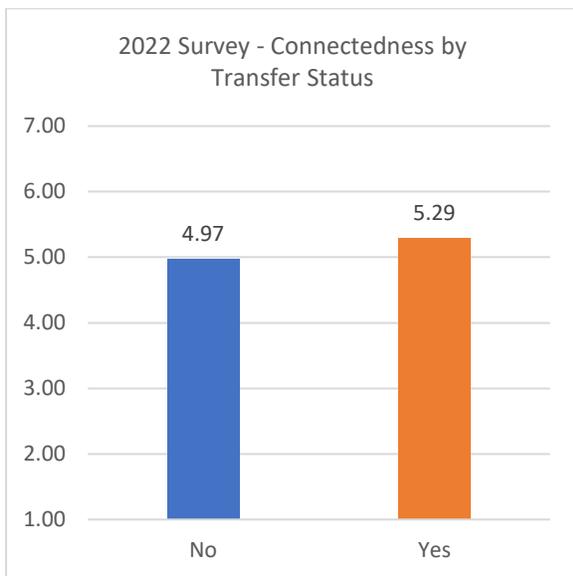
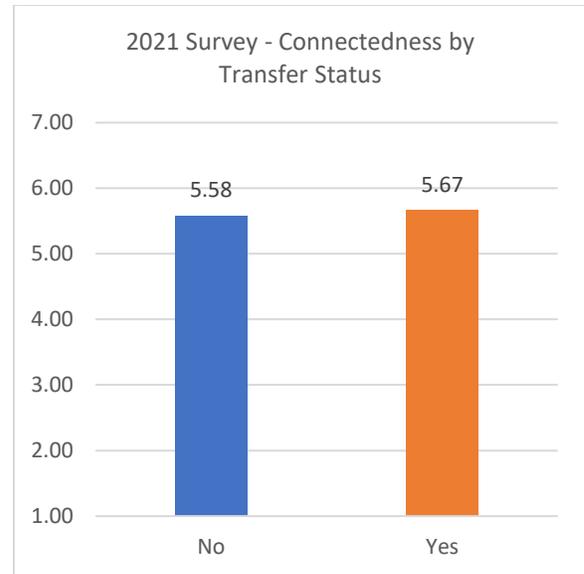
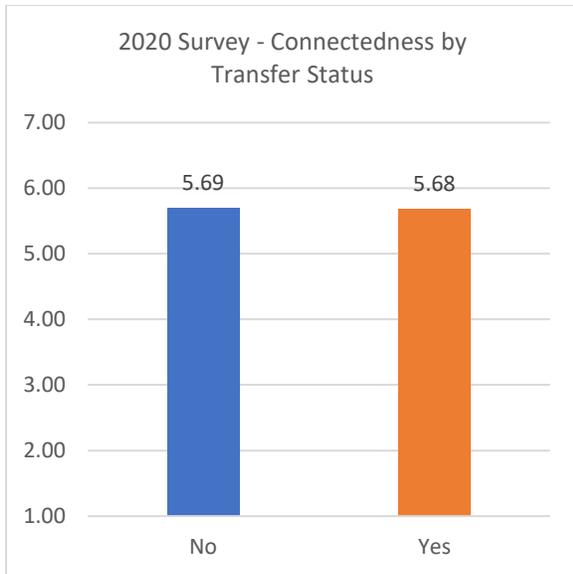
First-generation College Status



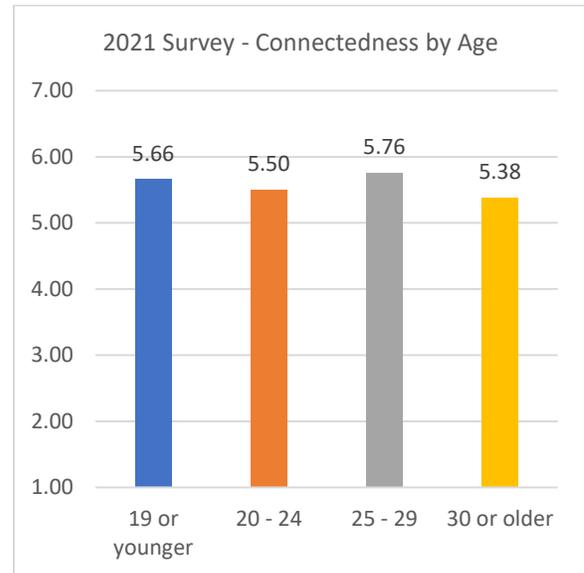
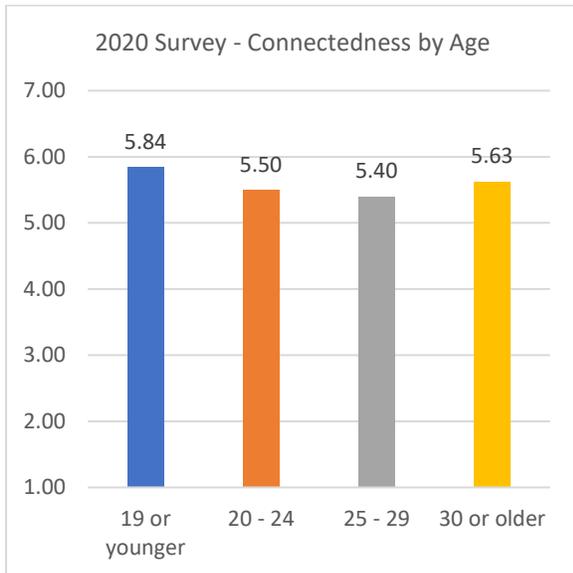
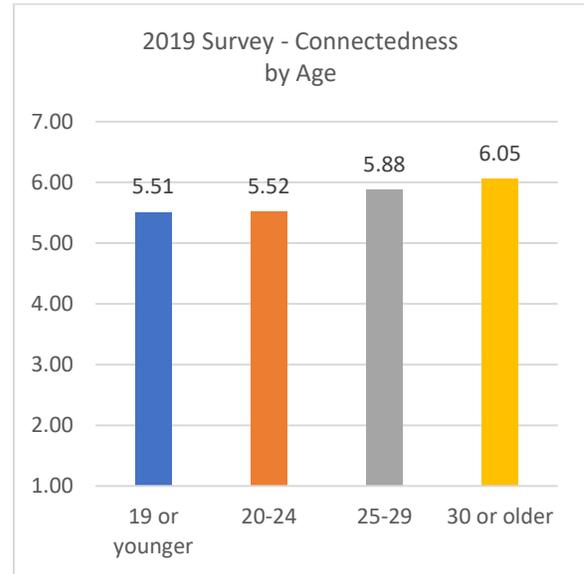
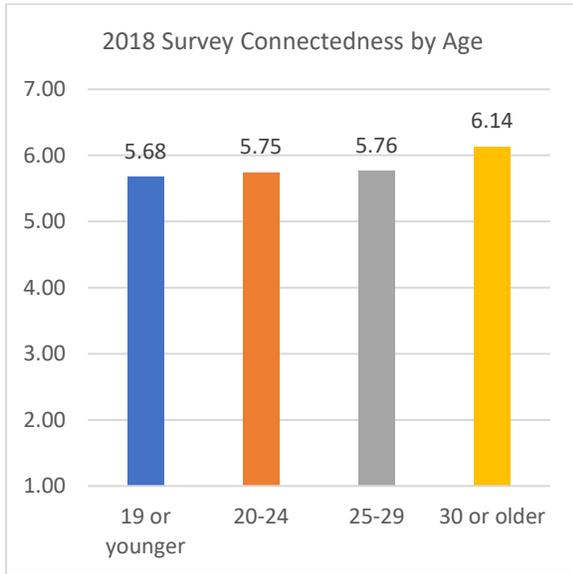


Transfer Status

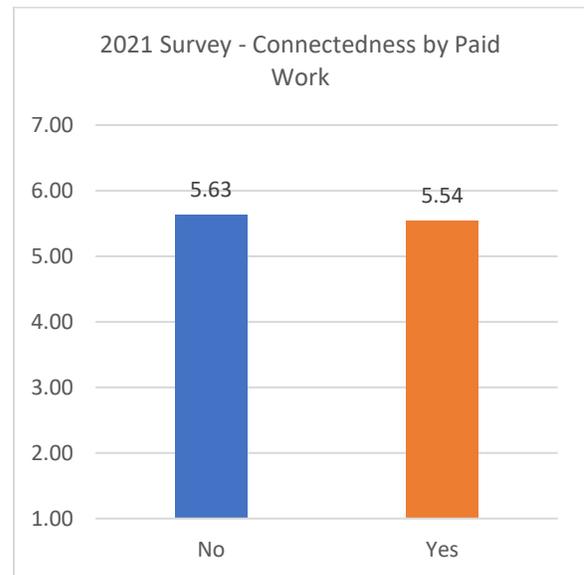
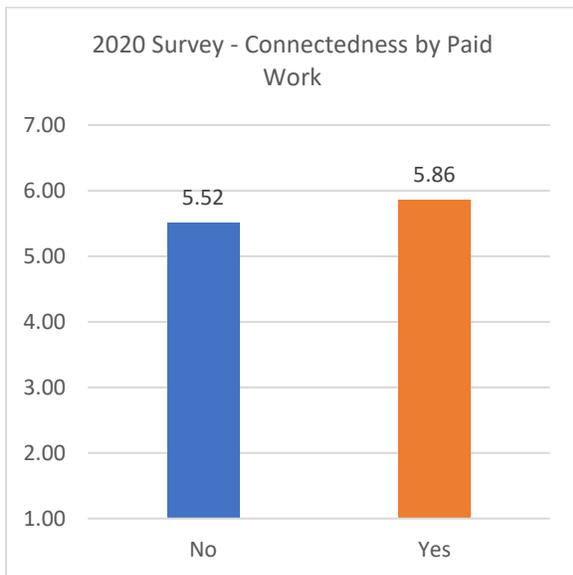
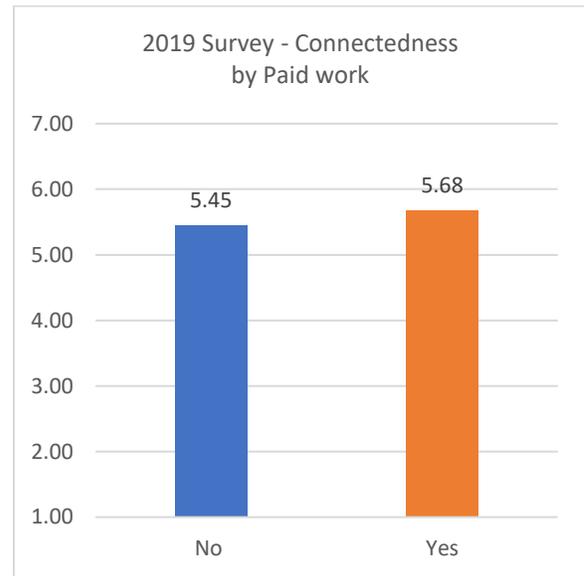
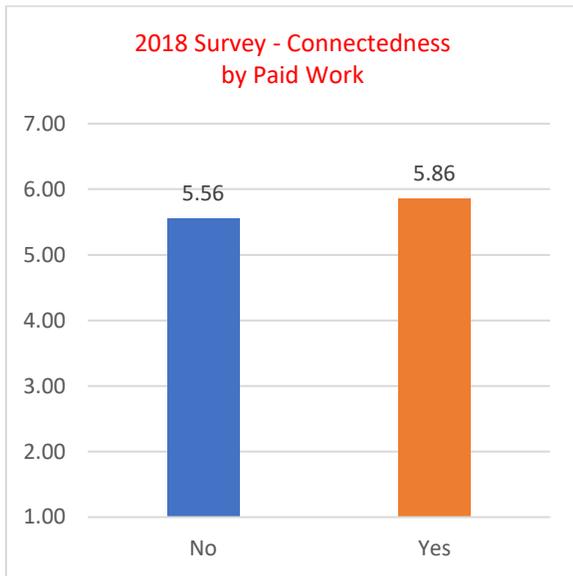


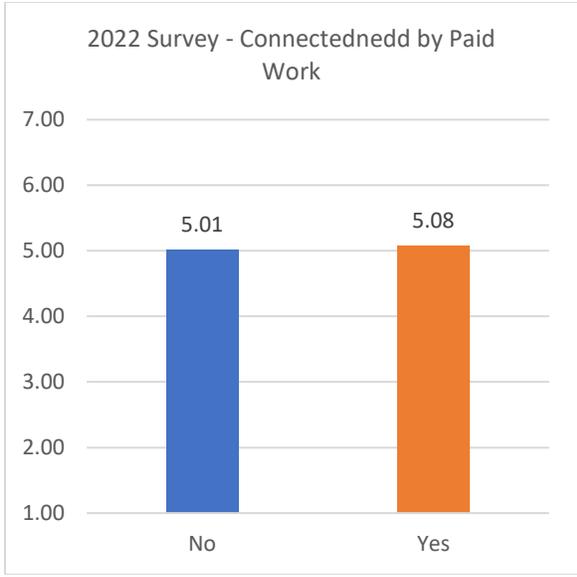


Age



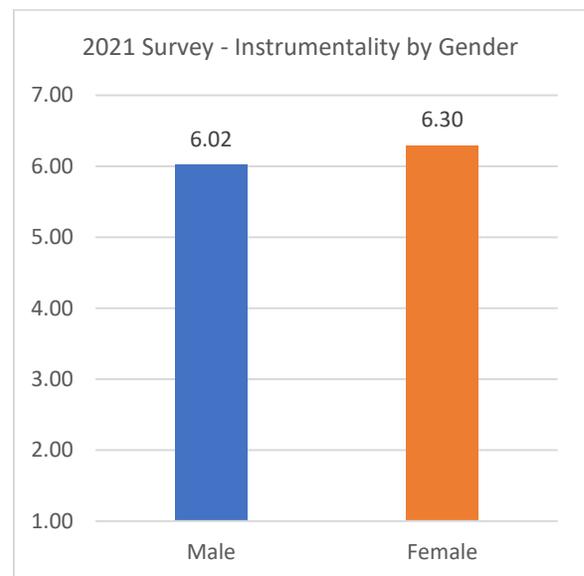
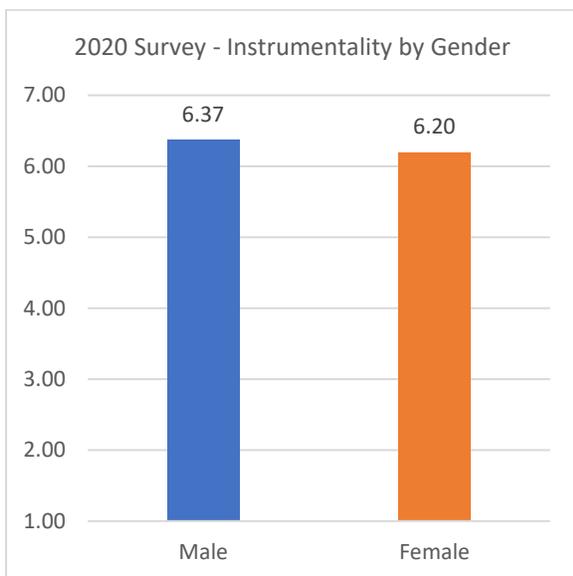
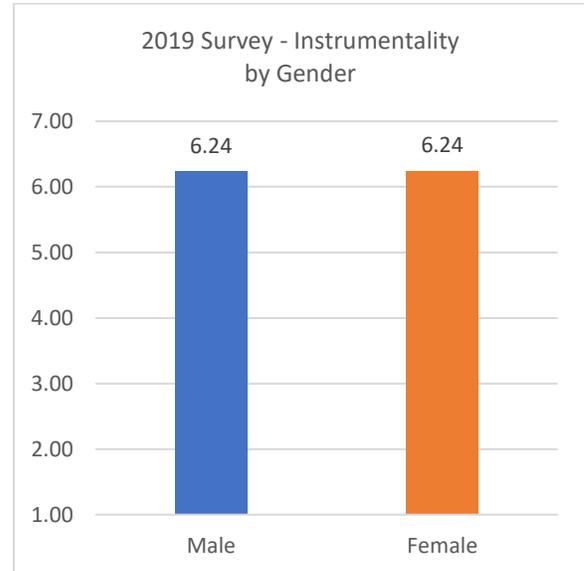
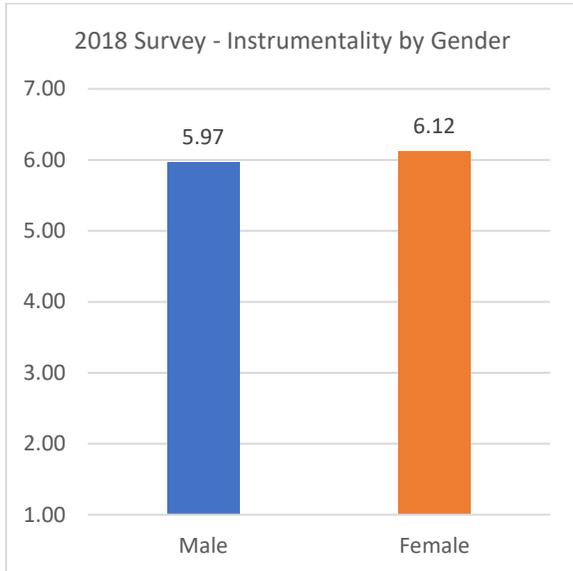
Employment status

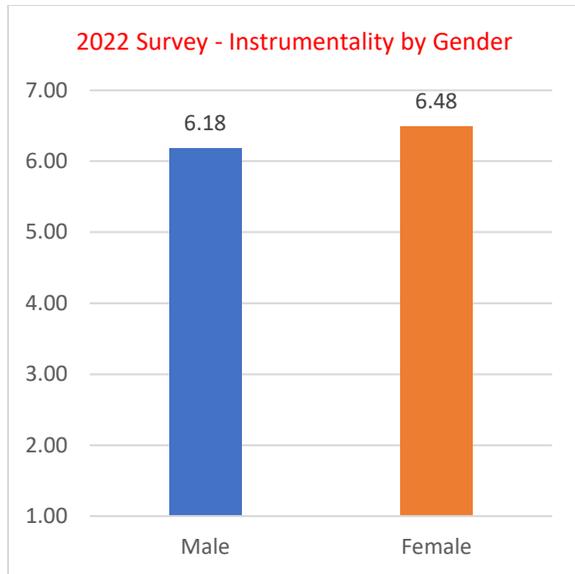




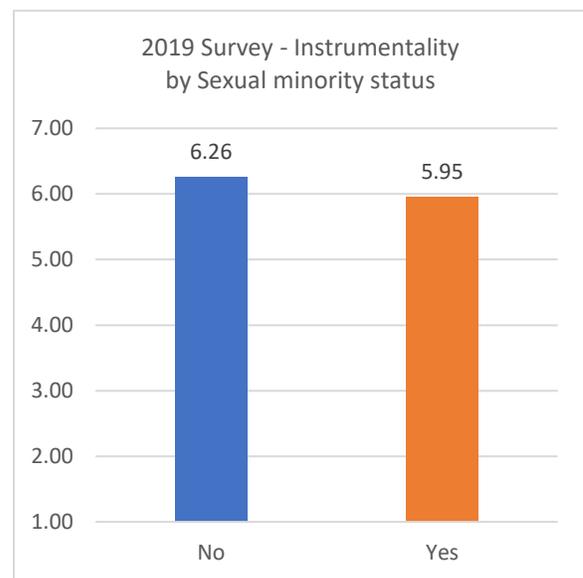
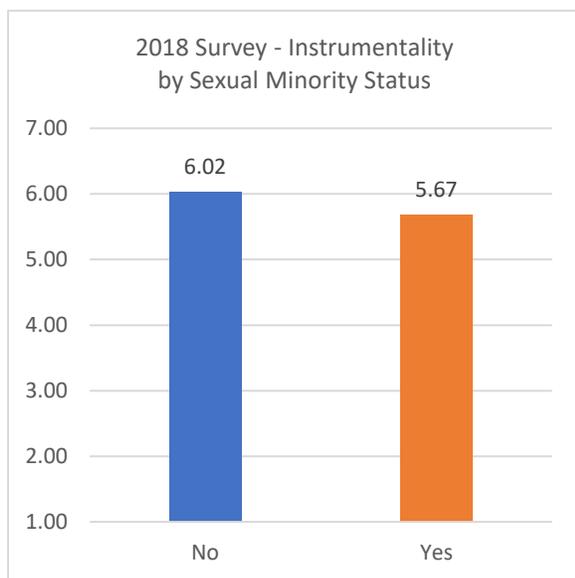
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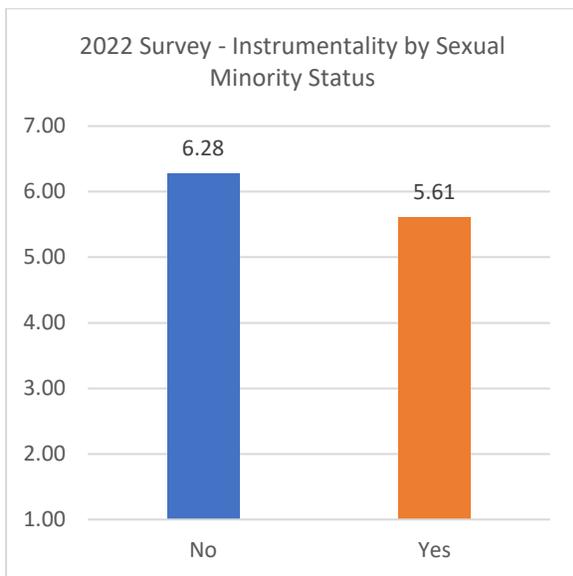
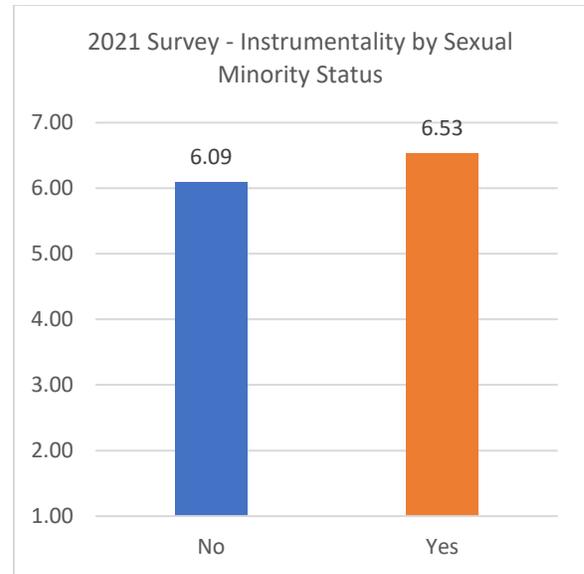
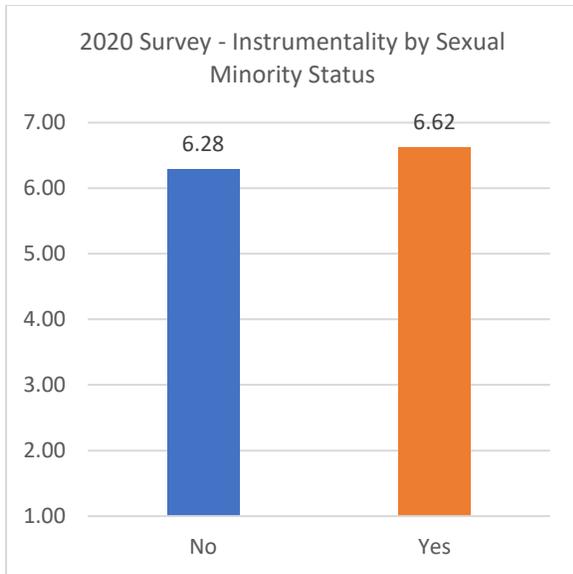
Gender



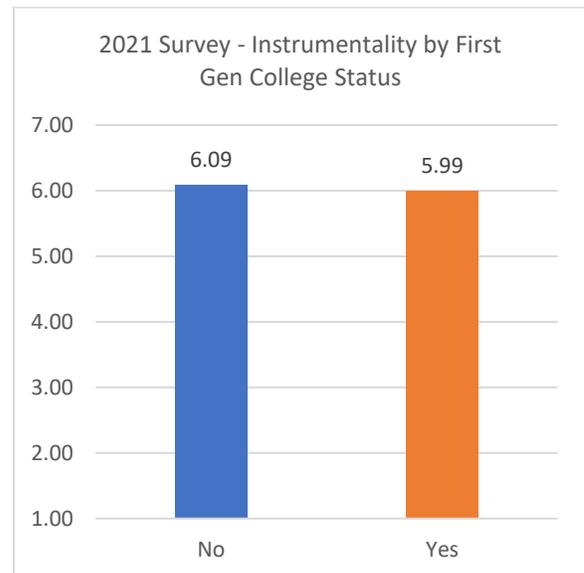
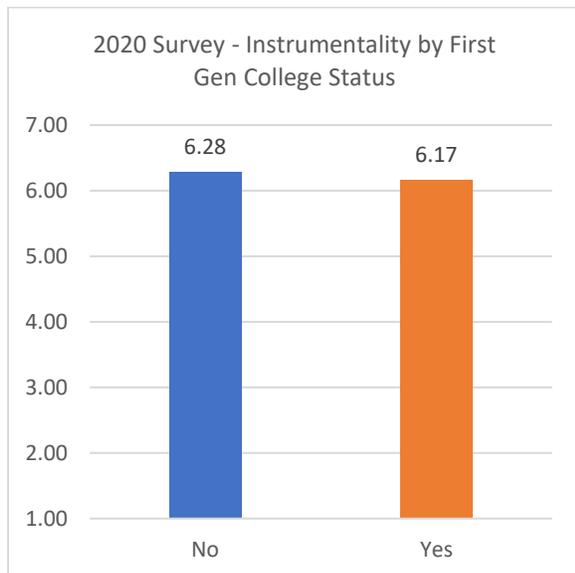
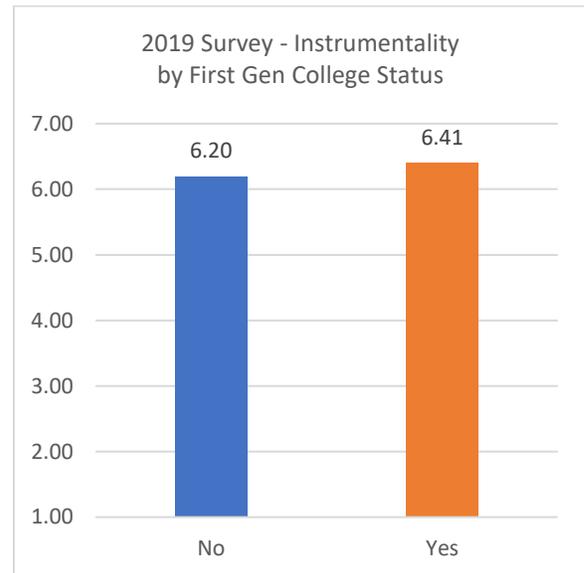
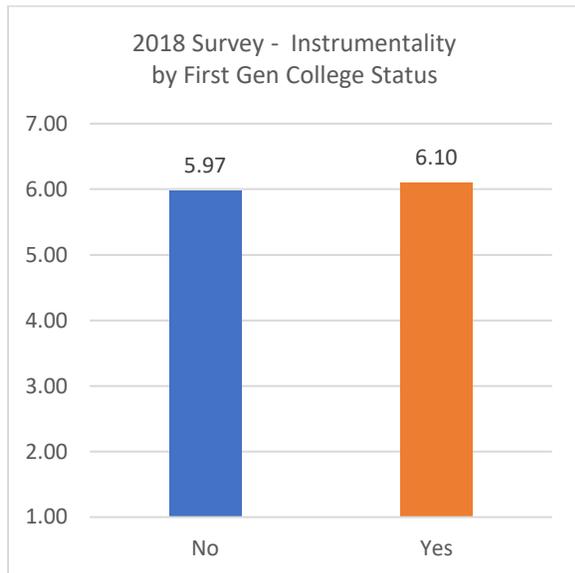


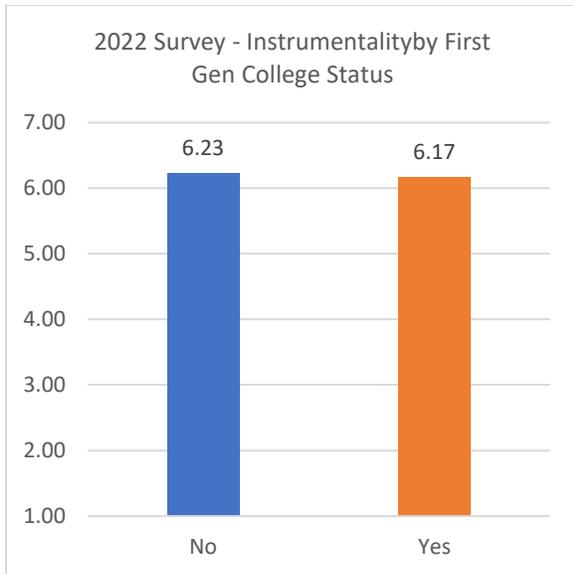
Sexual Minority Status



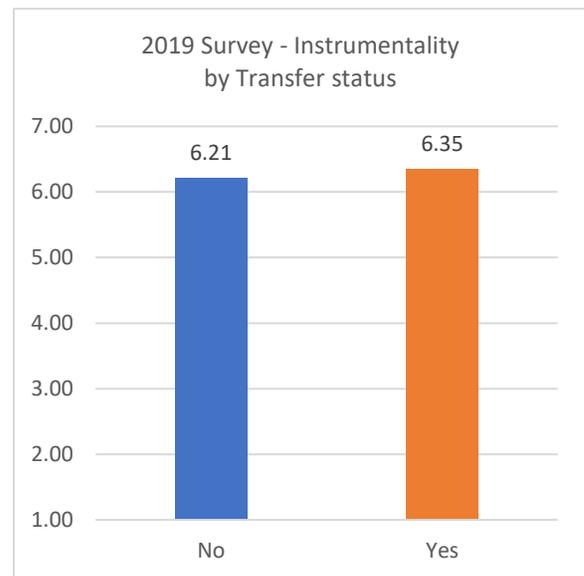
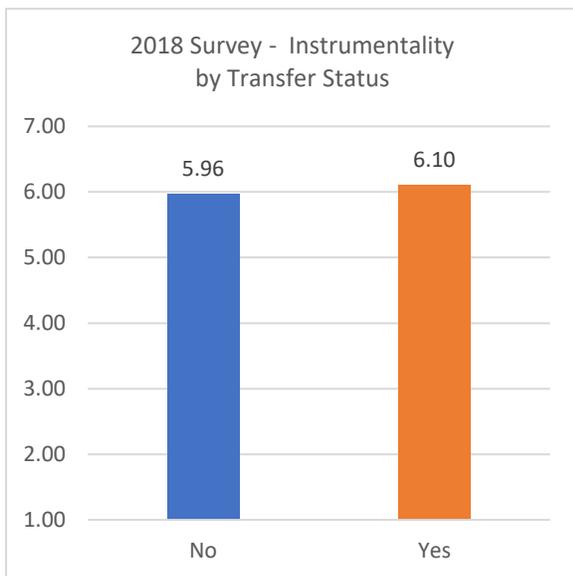


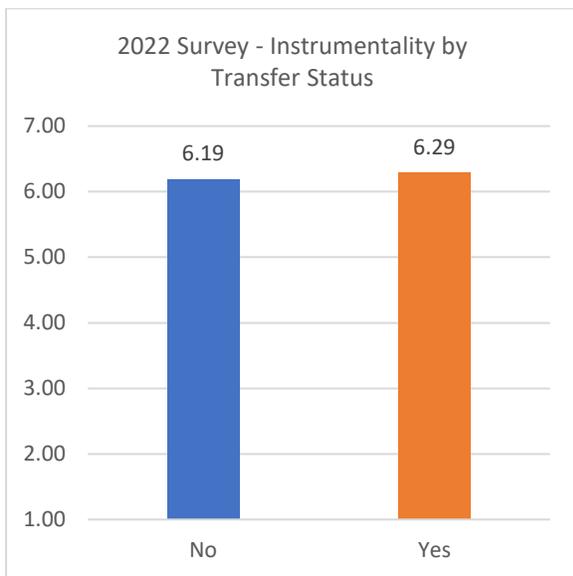
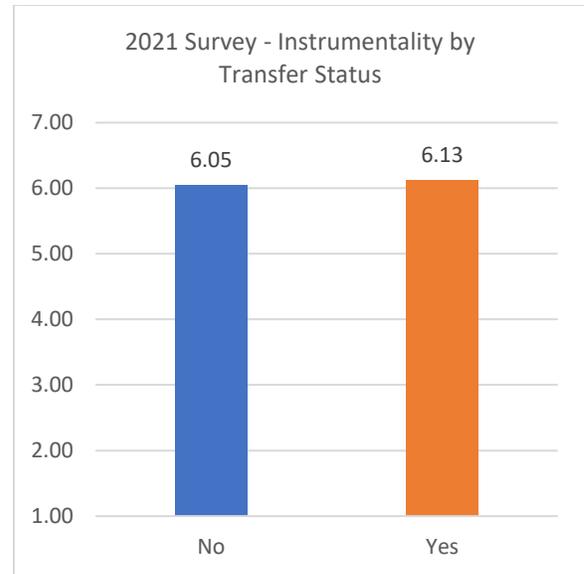
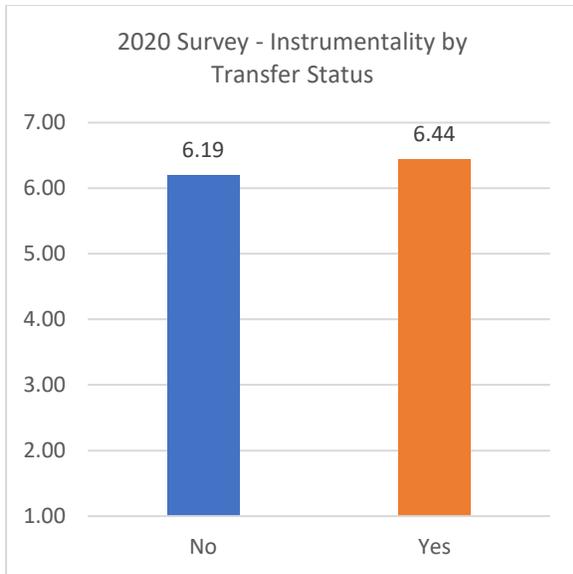
First-generation College Status



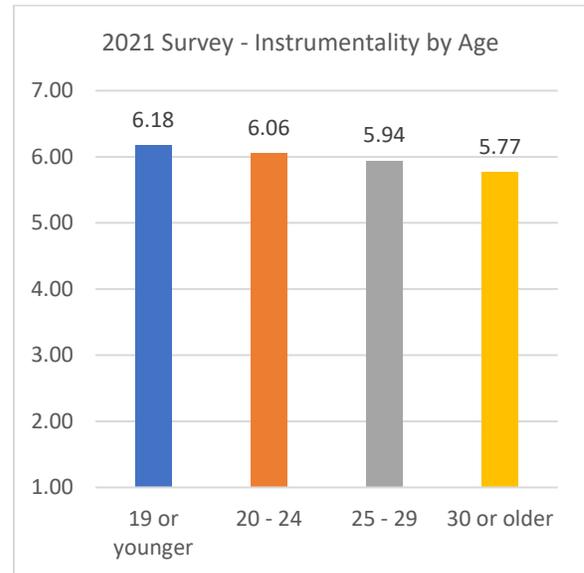
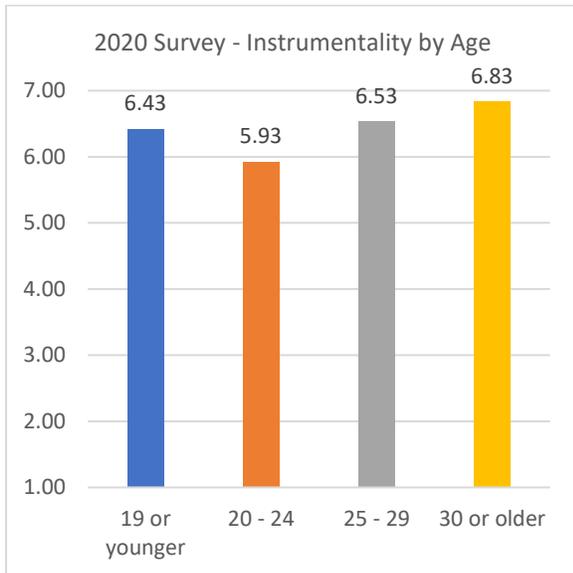
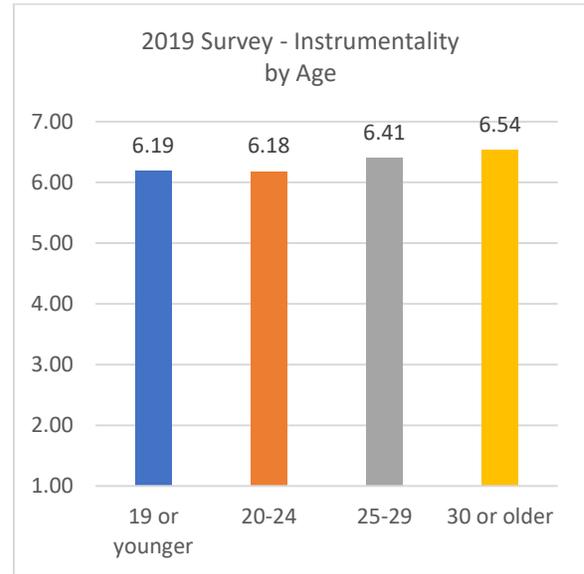
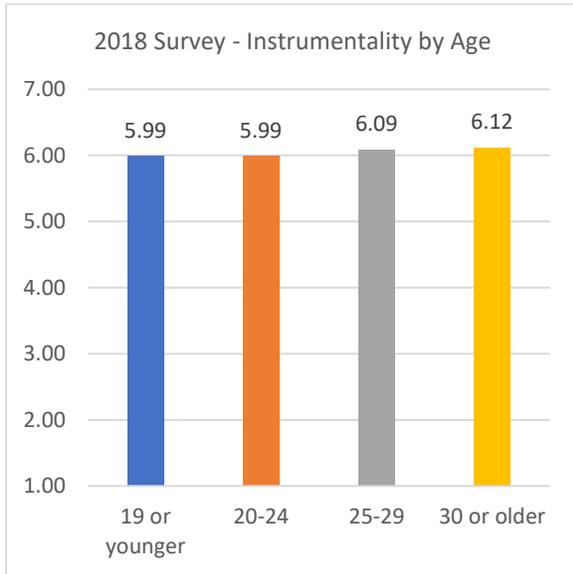


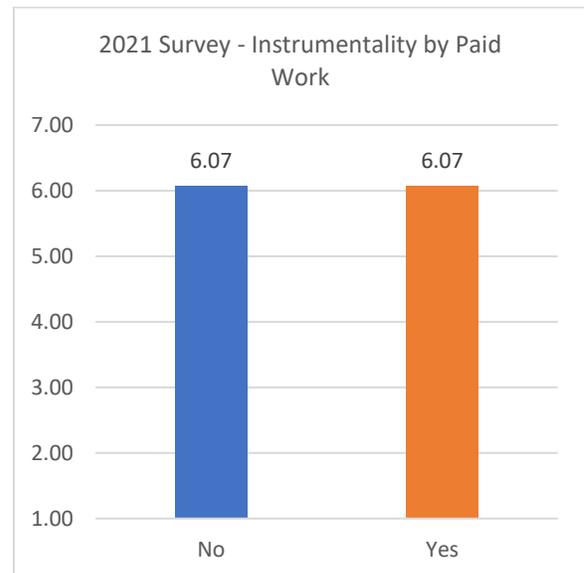
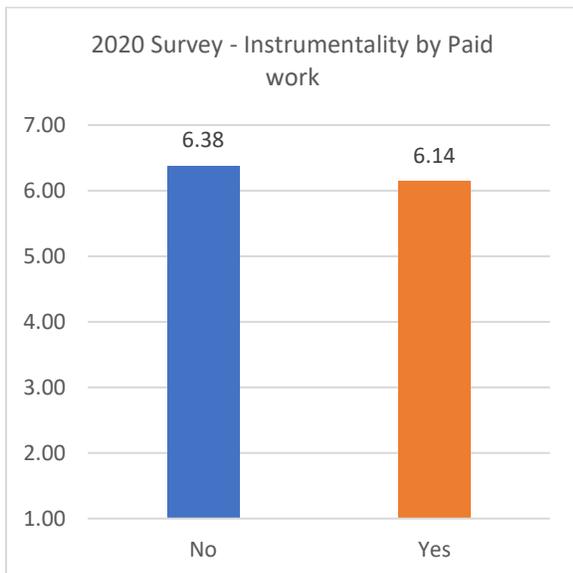
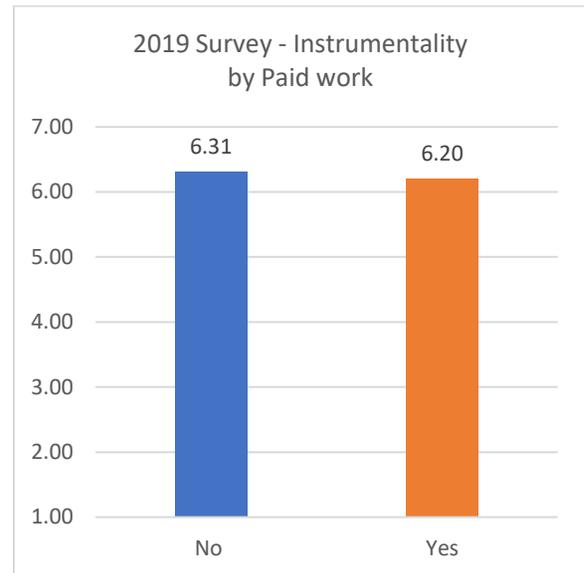
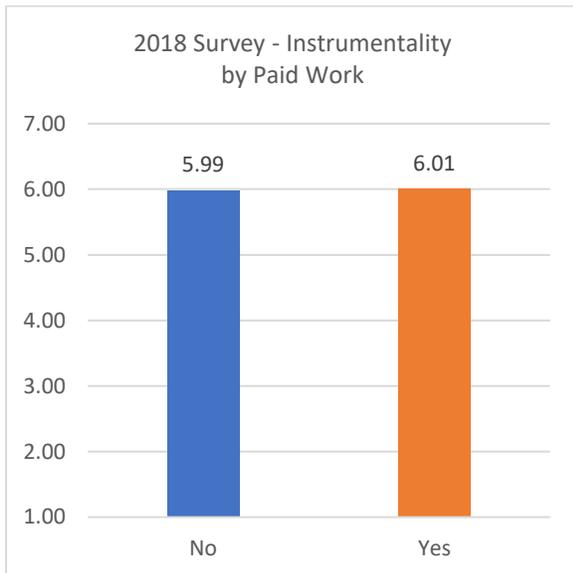
Transfer Status

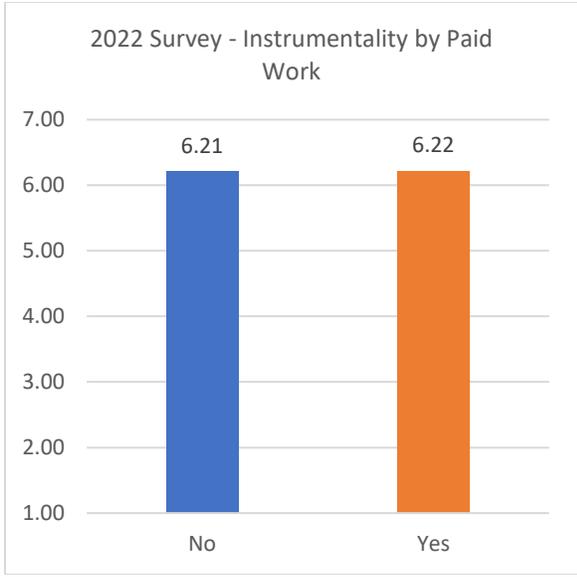




Age

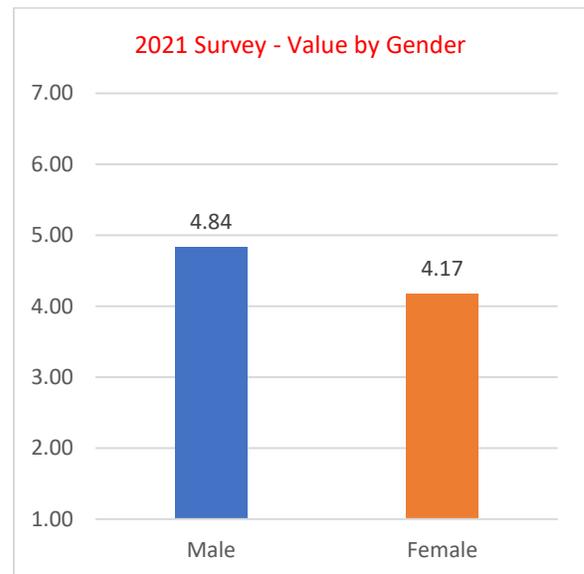
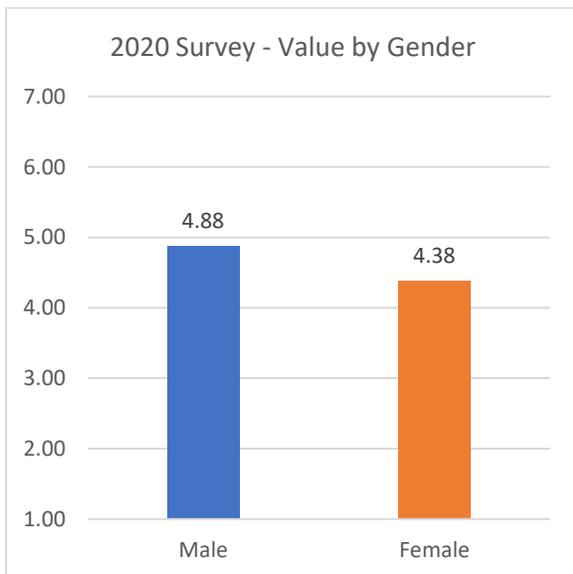
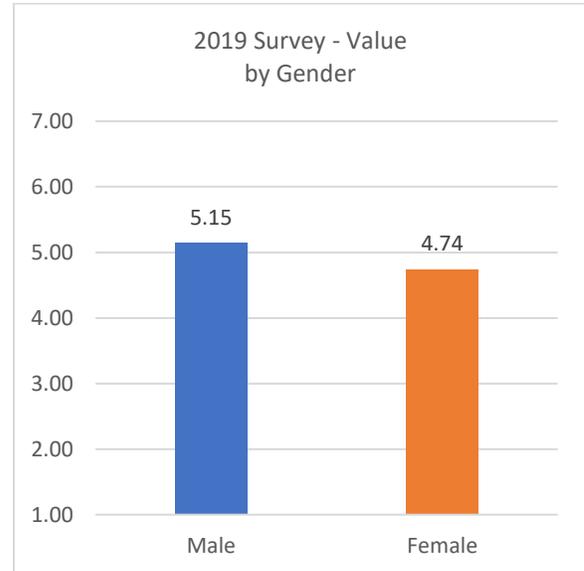
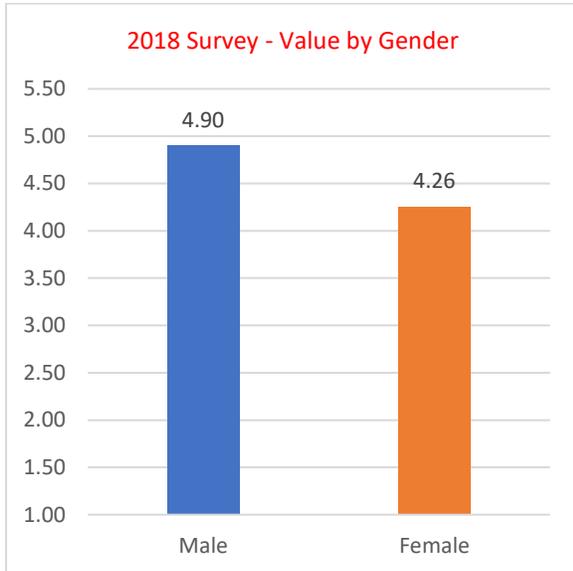


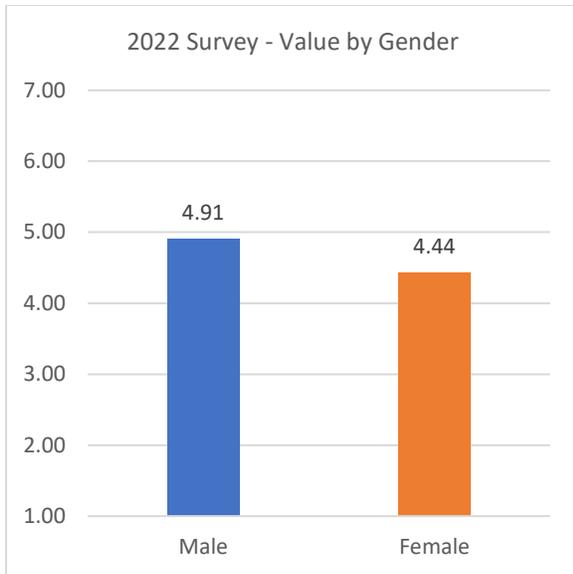
Employment status



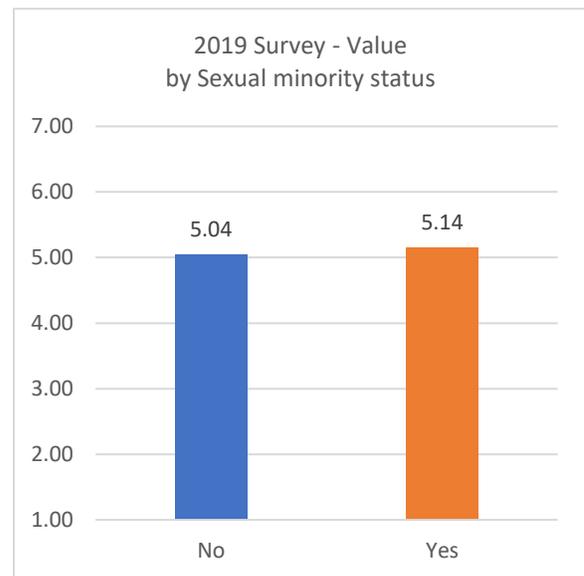
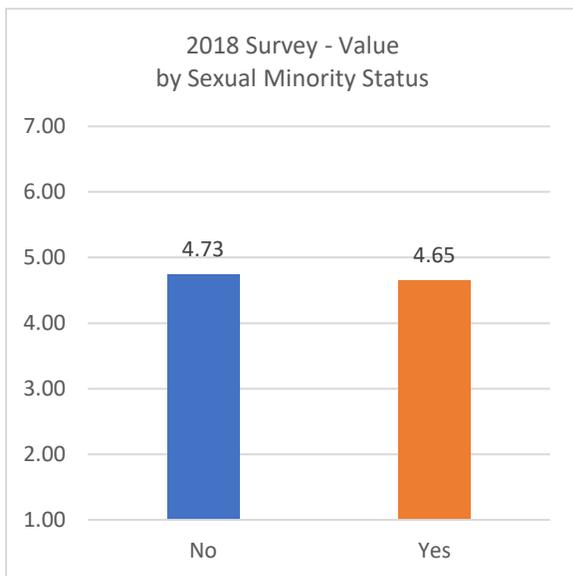
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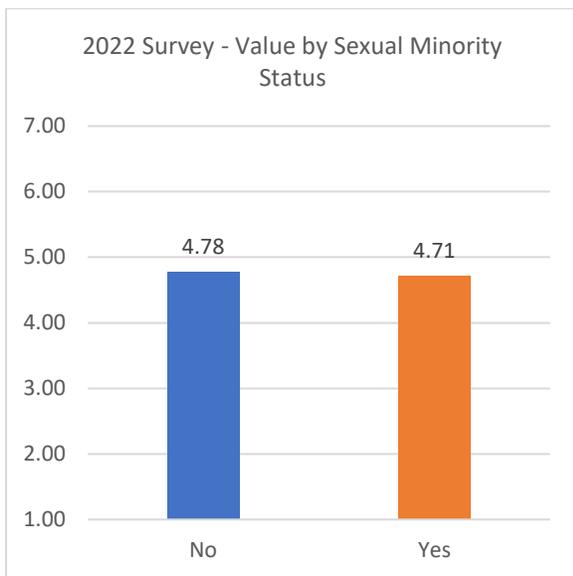
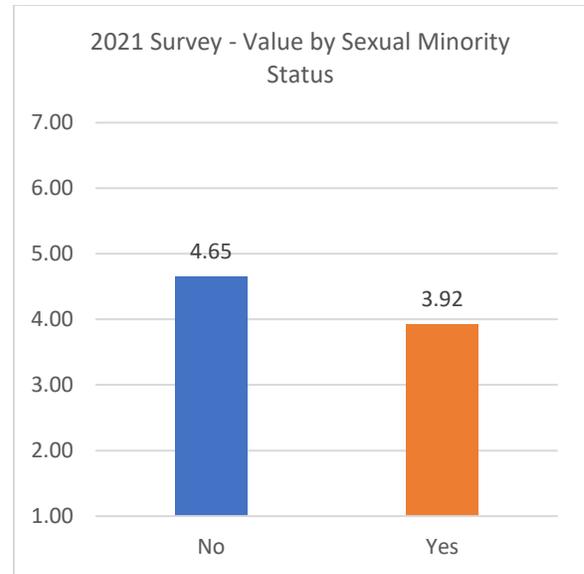
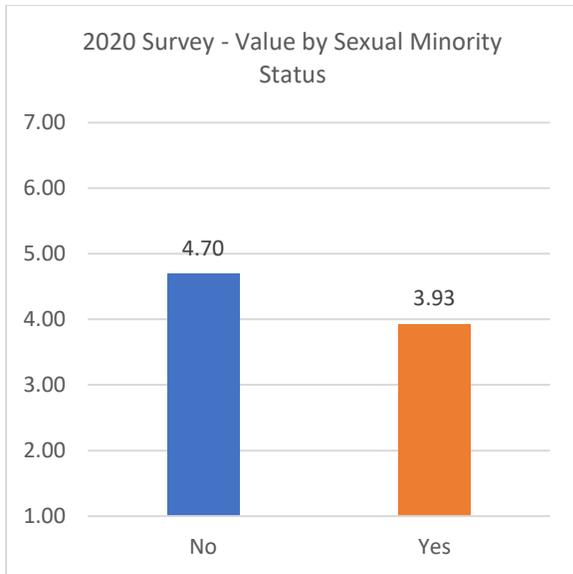
Gender



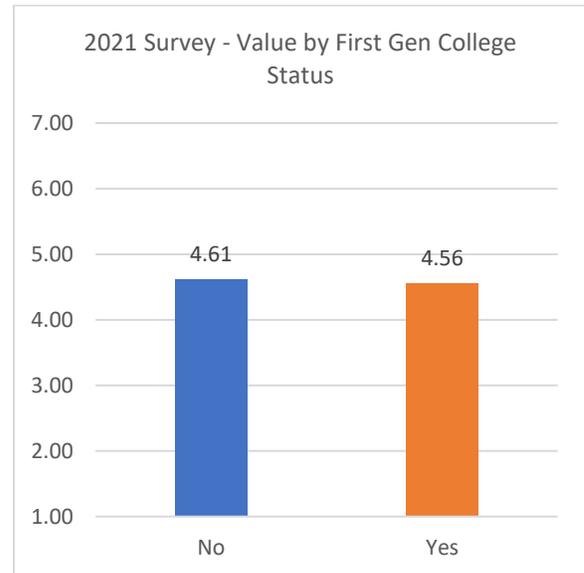
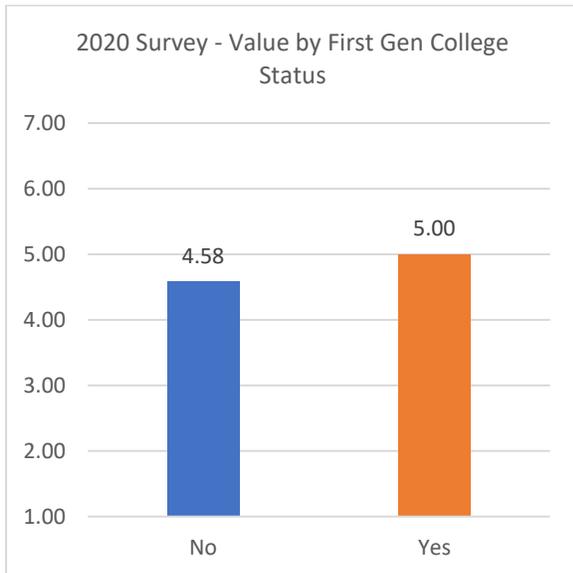
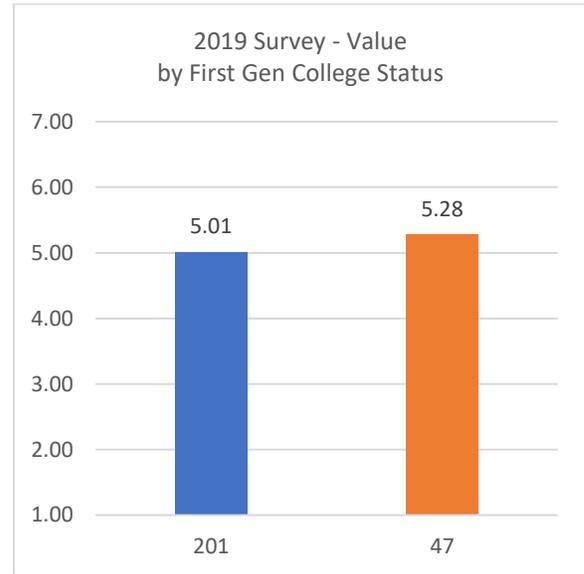
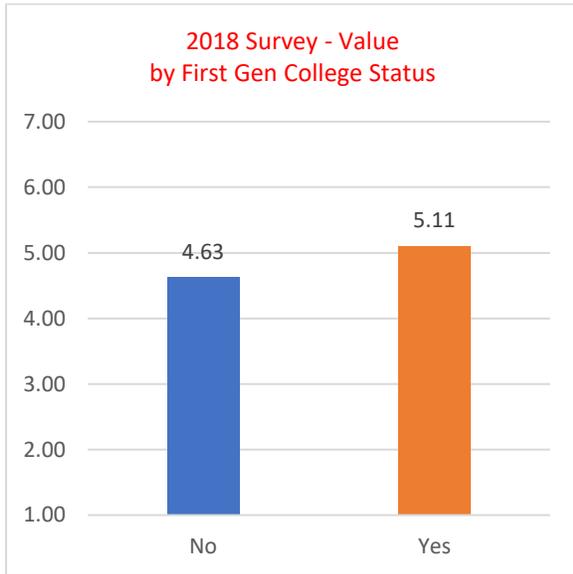


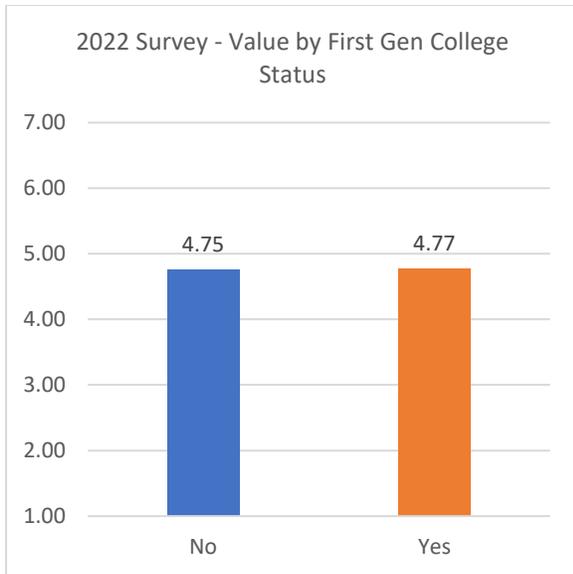
Sexual Minority Status



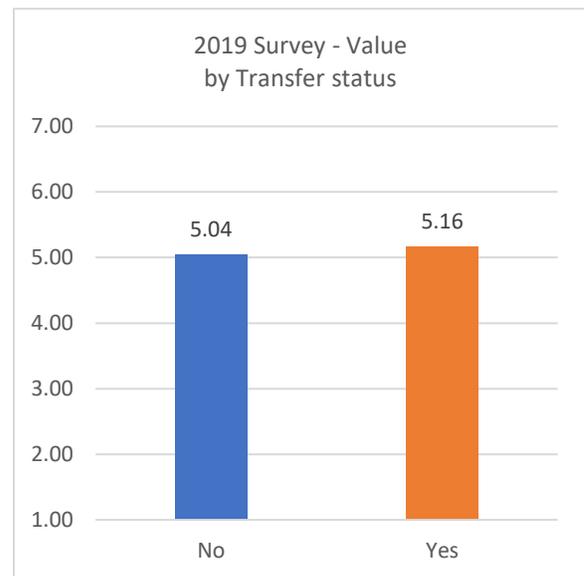
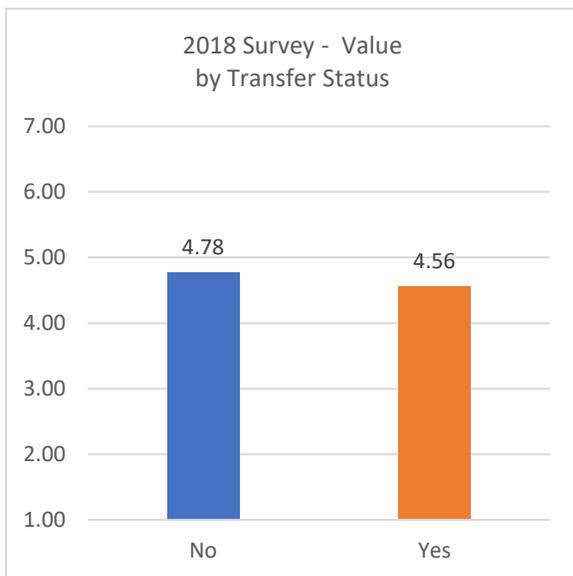


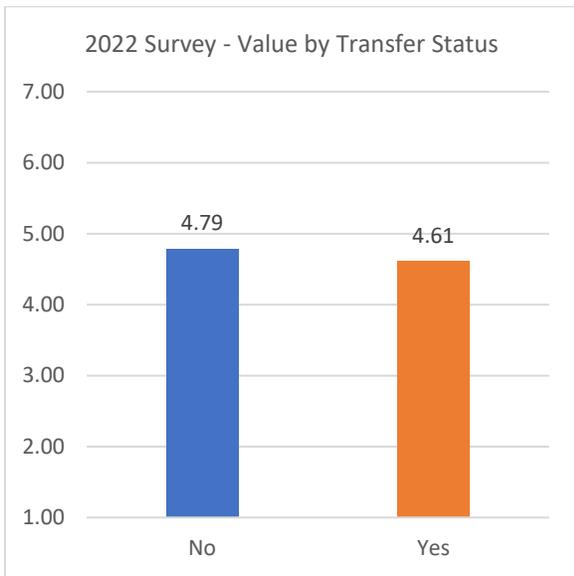
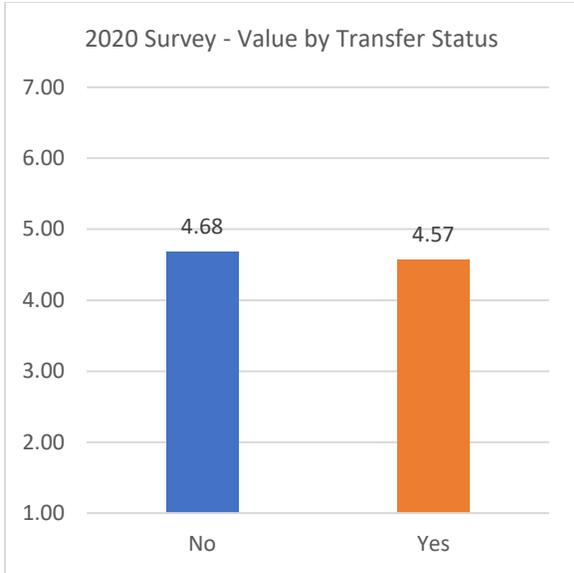
First-generation College Status



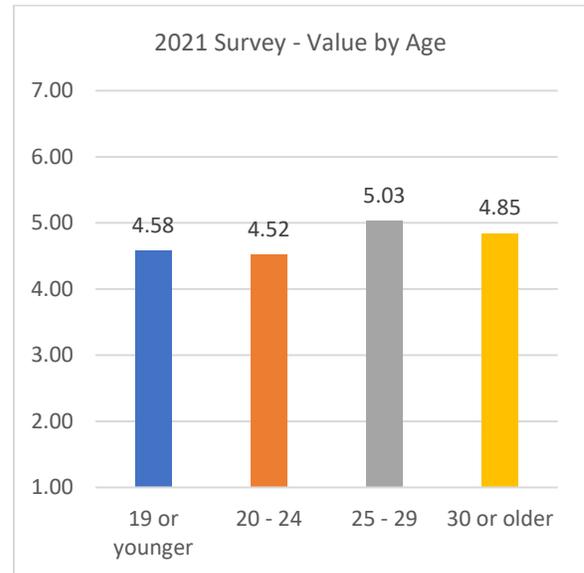
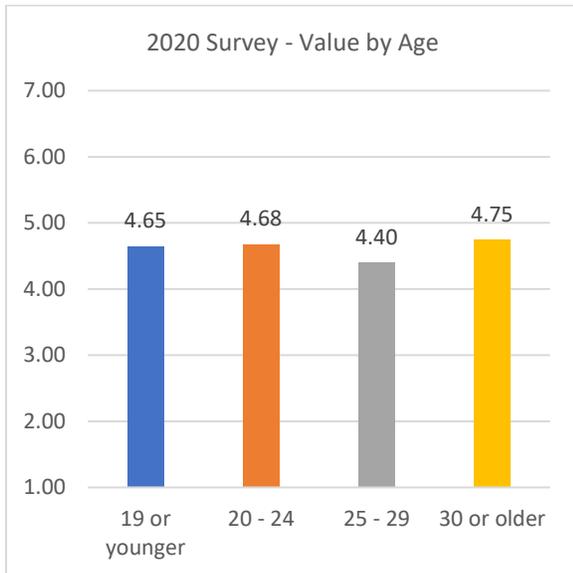
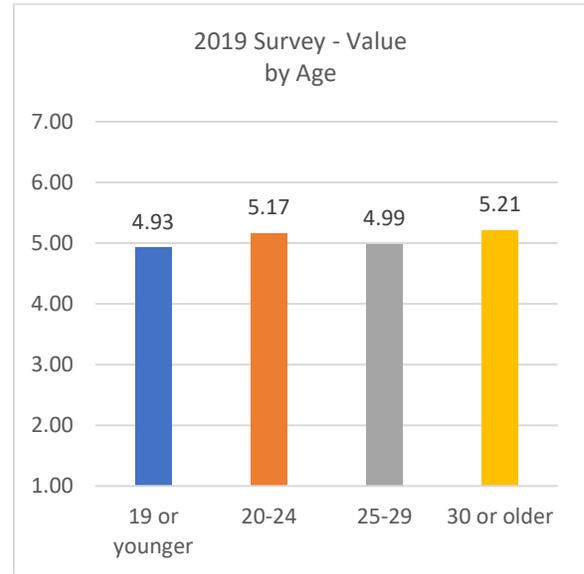
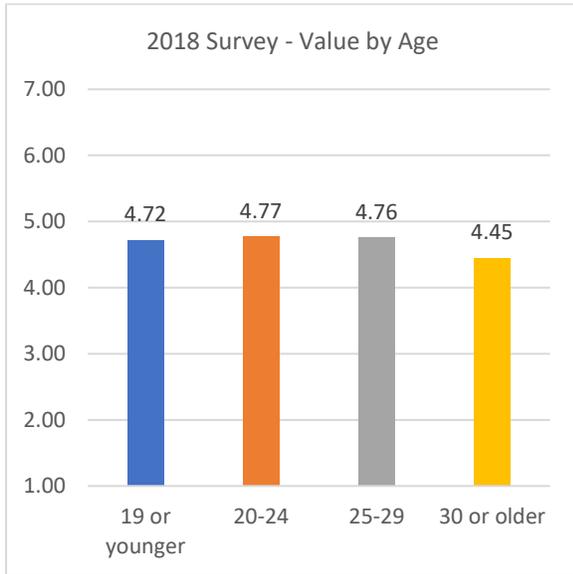


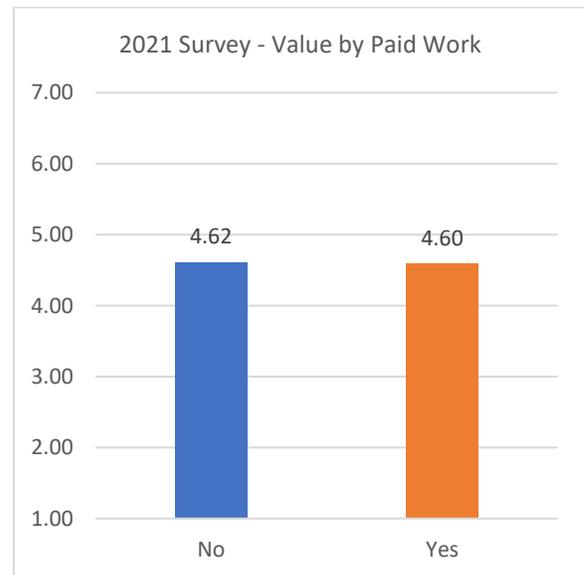
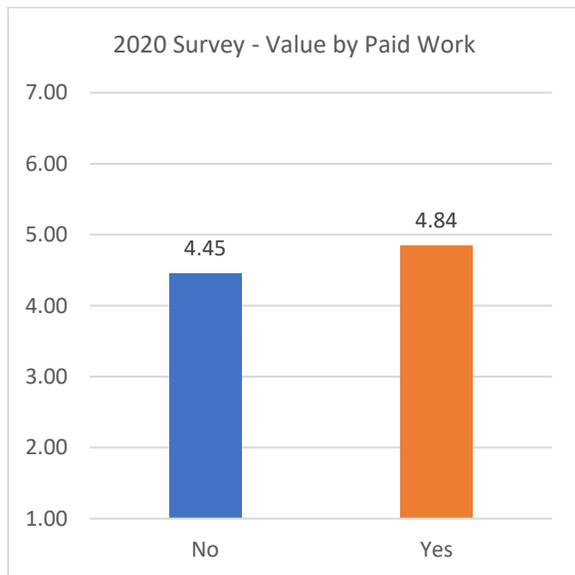
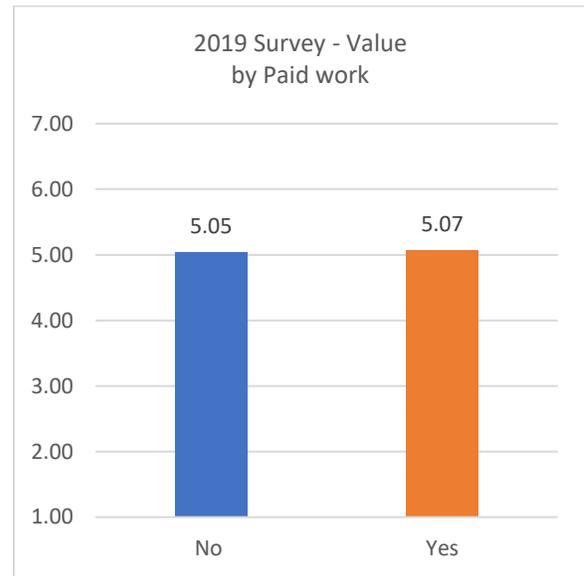
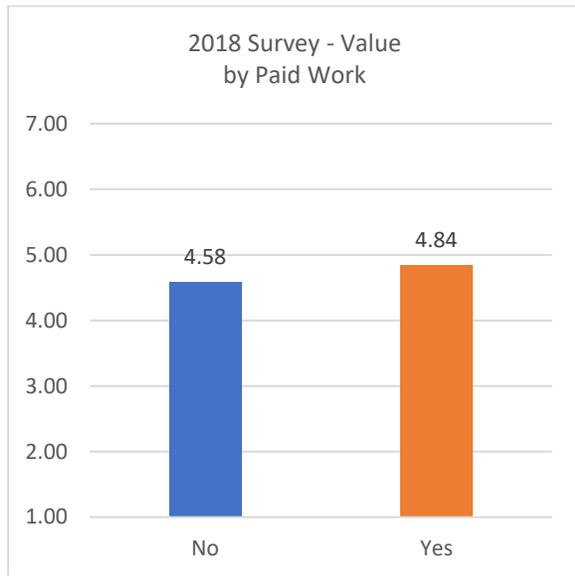
Transfer Status

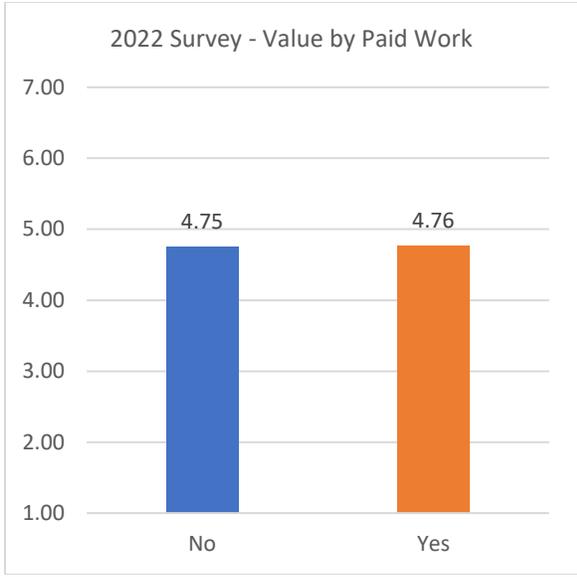




Age

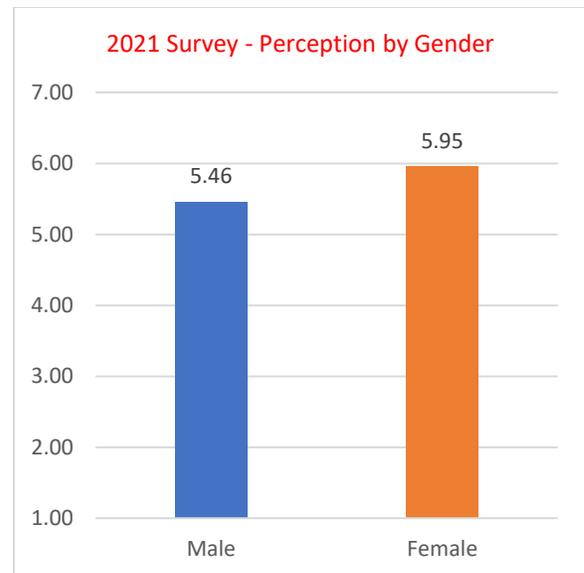
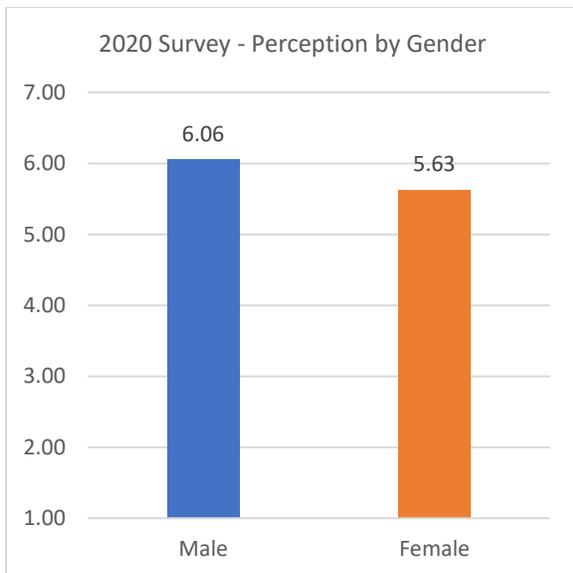
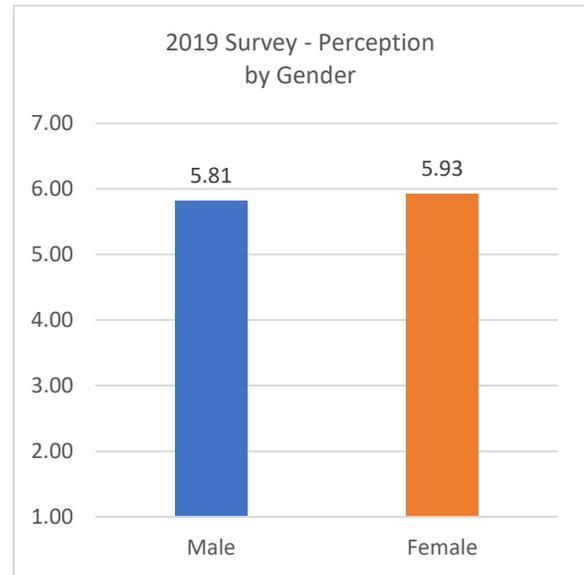
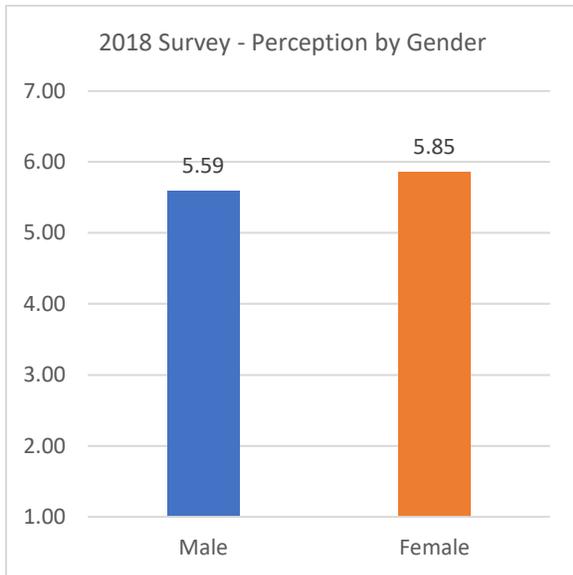


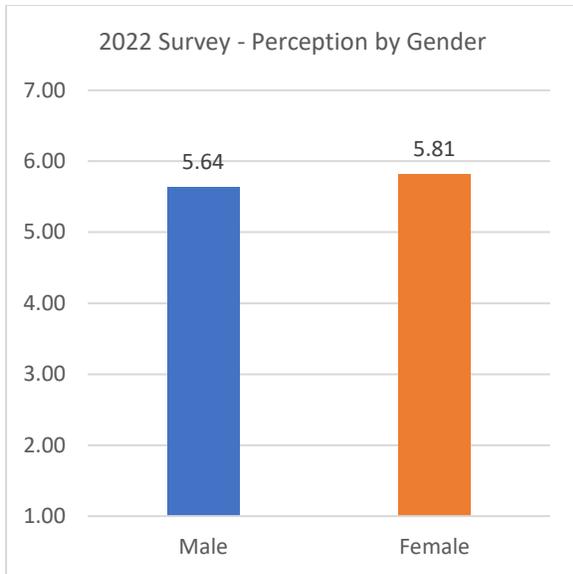
Employment status



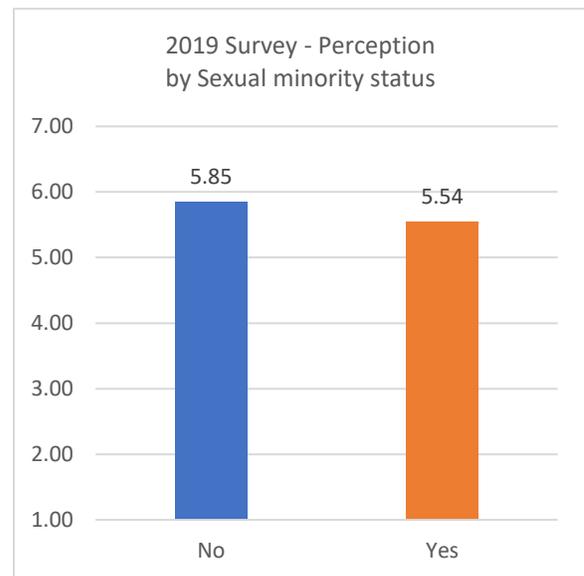
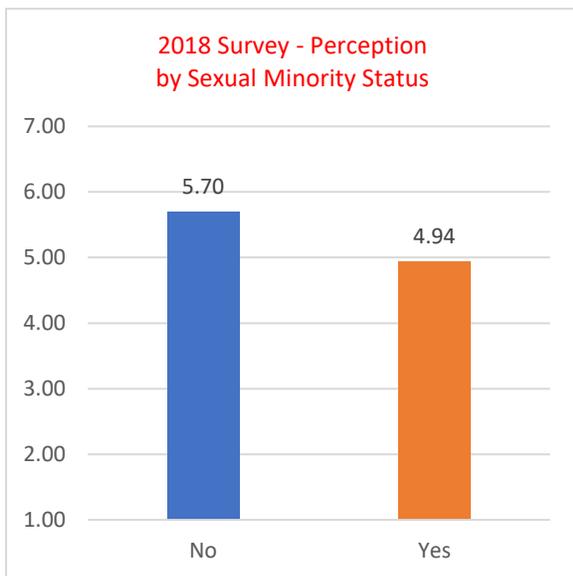
5) Perceptions

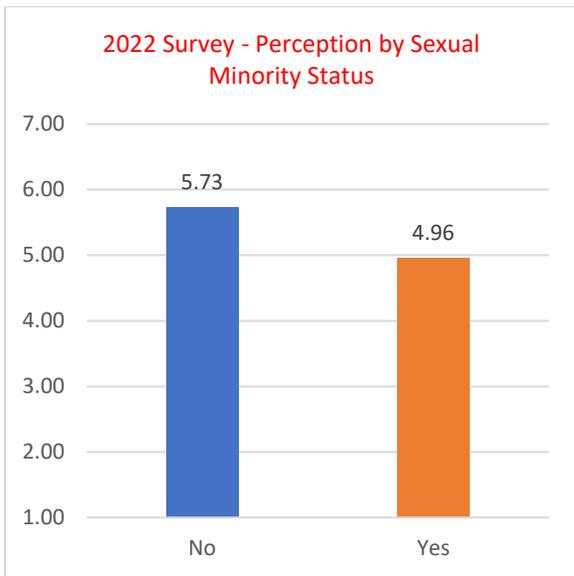
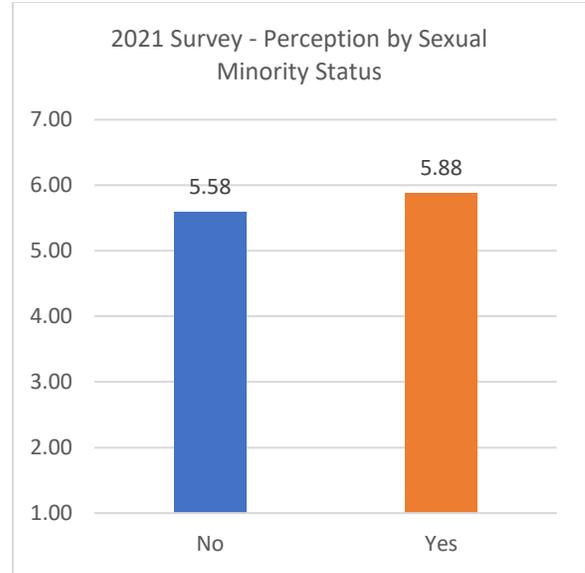
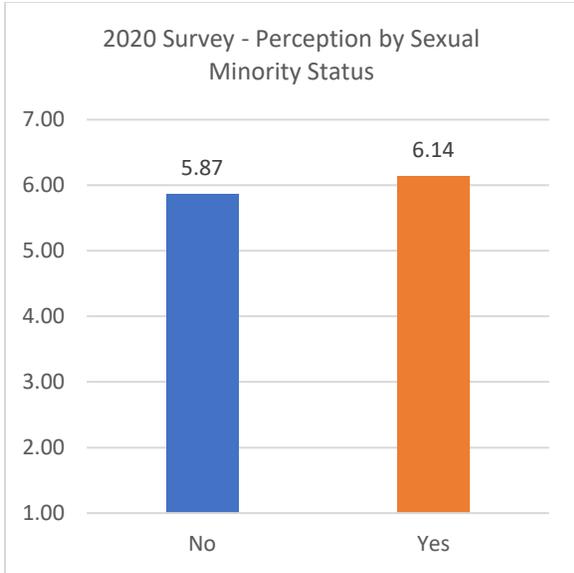
Gender



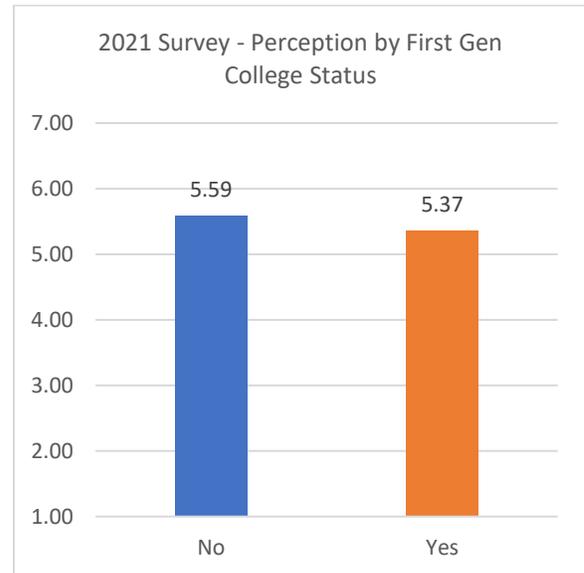
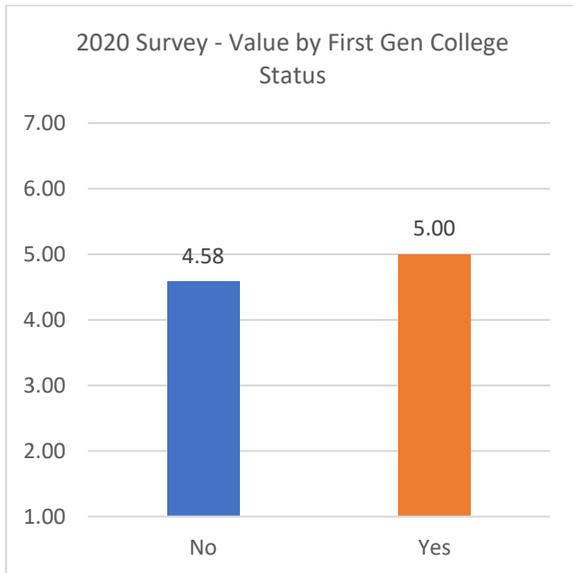
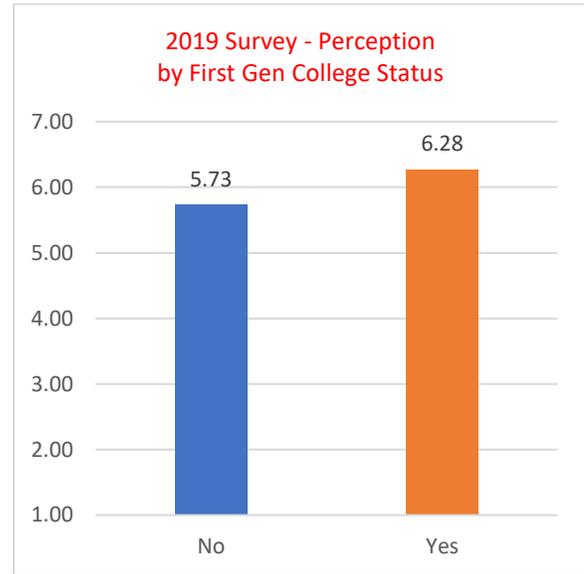
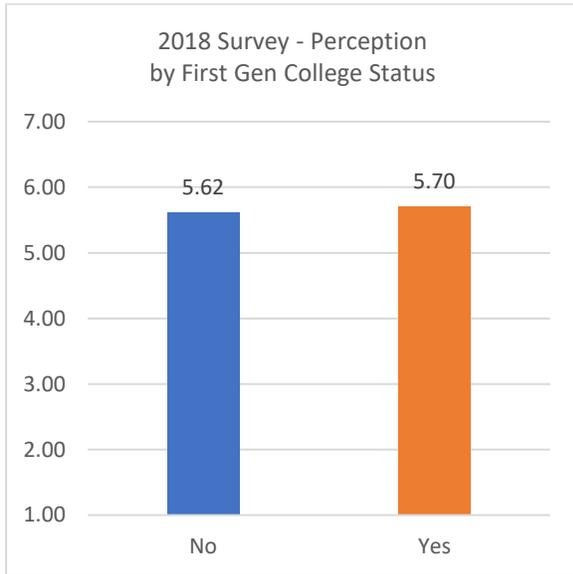


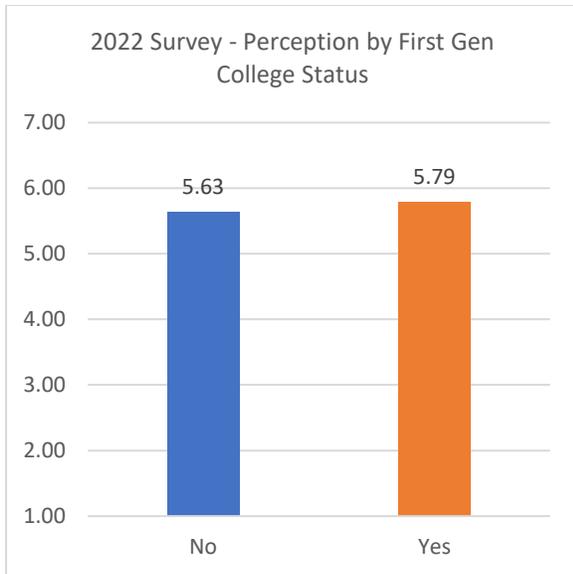
Sexual Minority Status



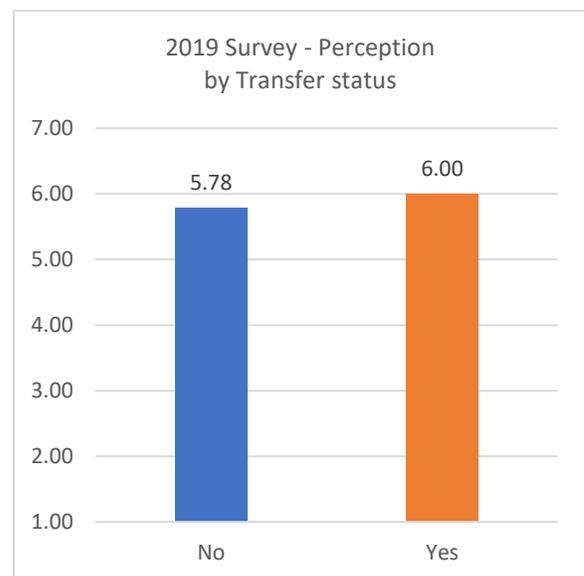
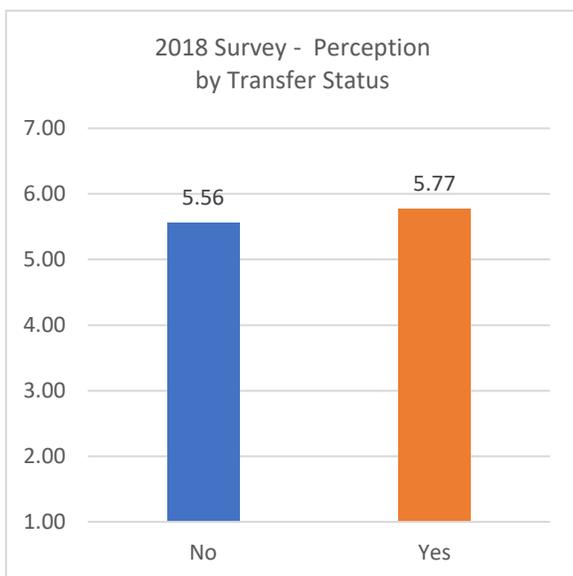


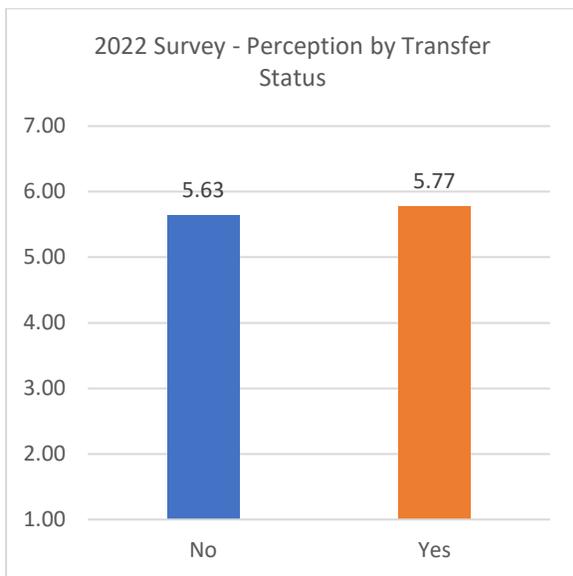
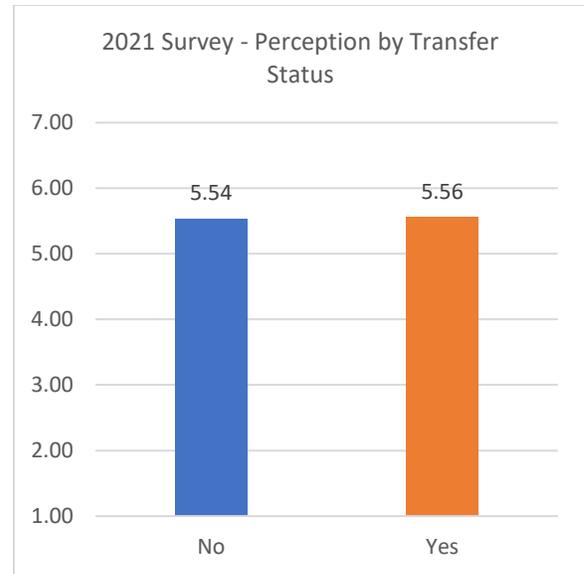
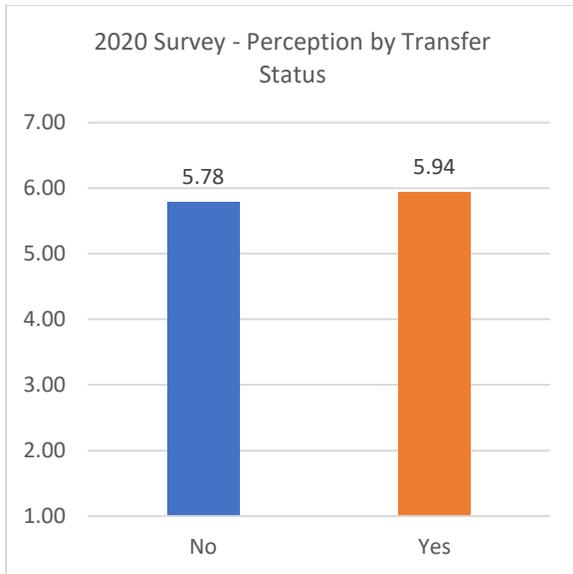
First-generation College Status



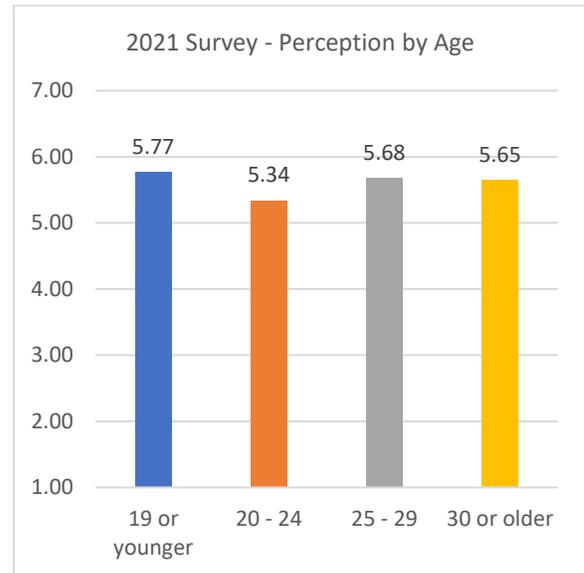
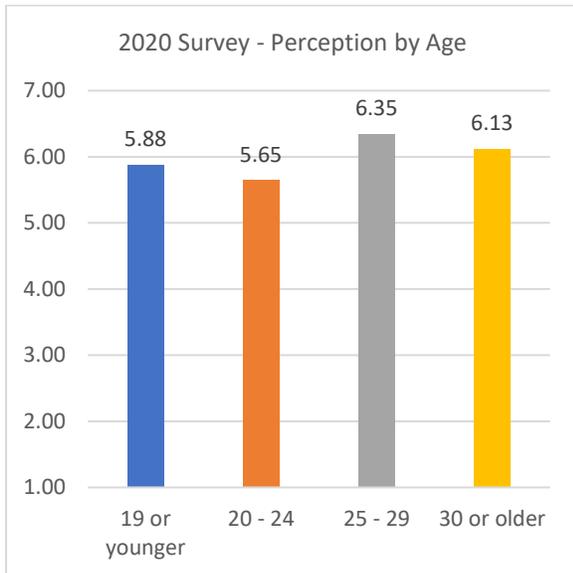
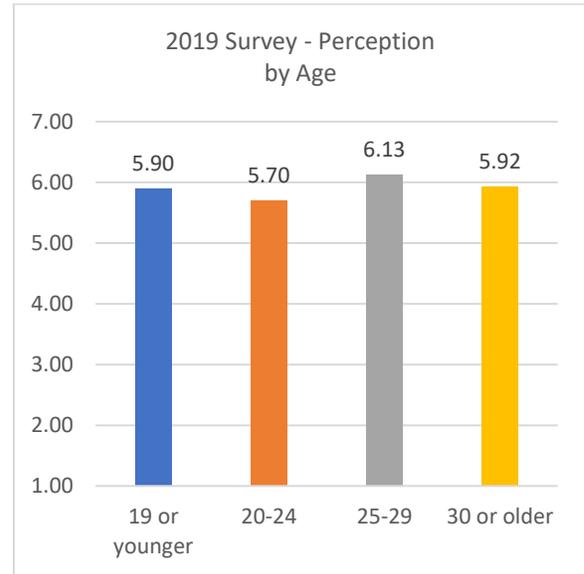
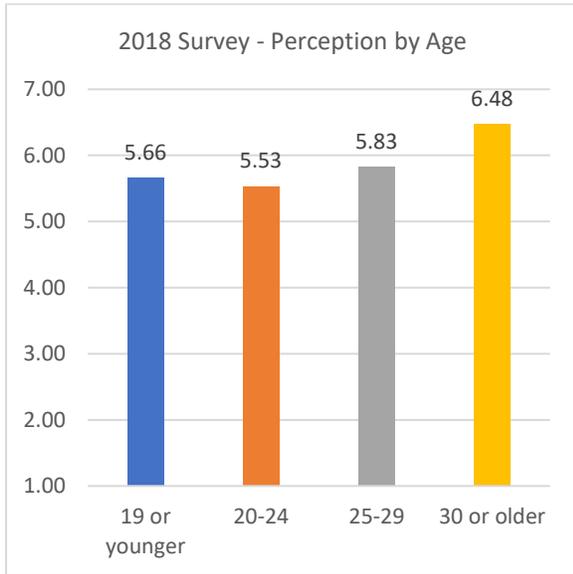


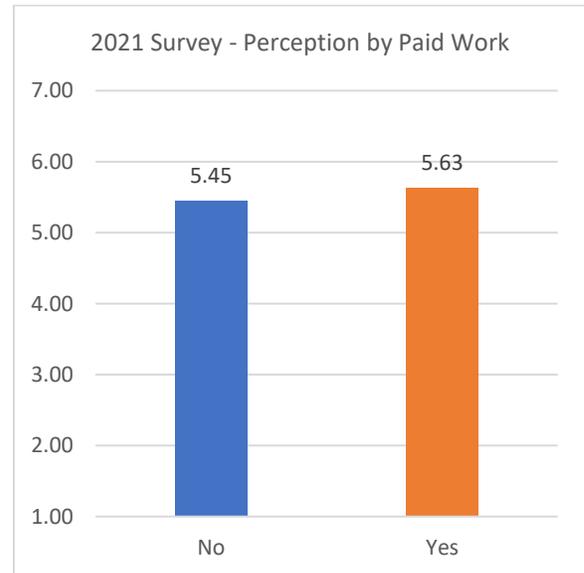
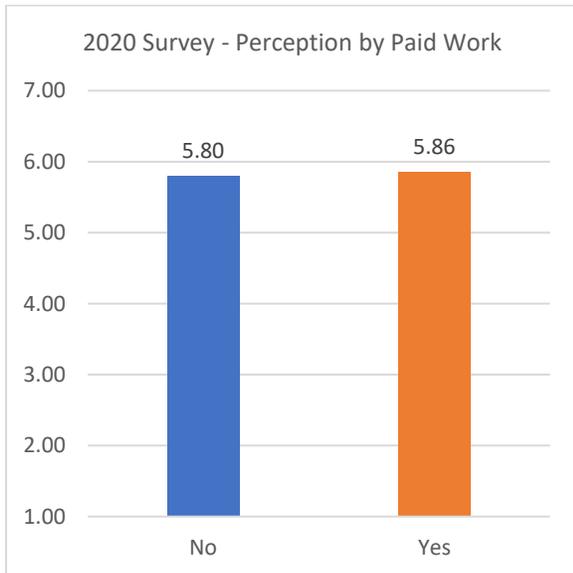
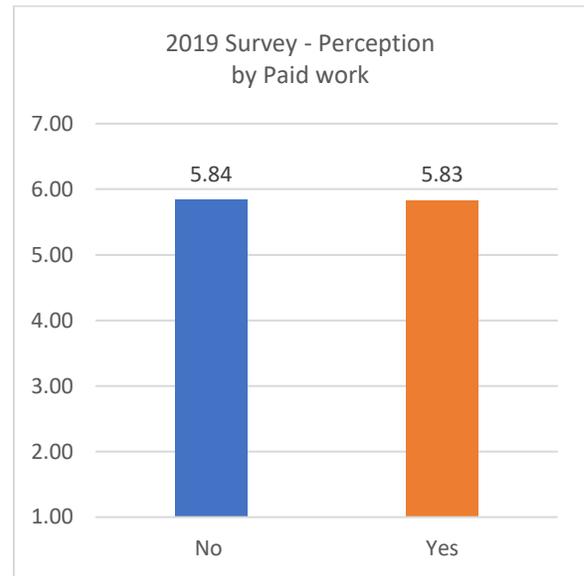
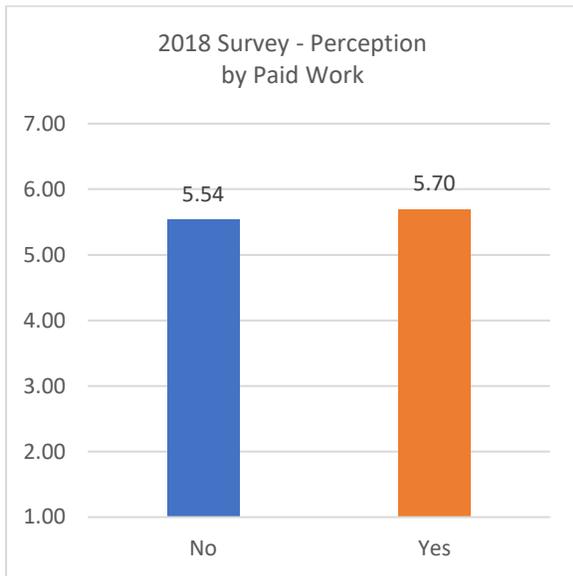
Transfer Status

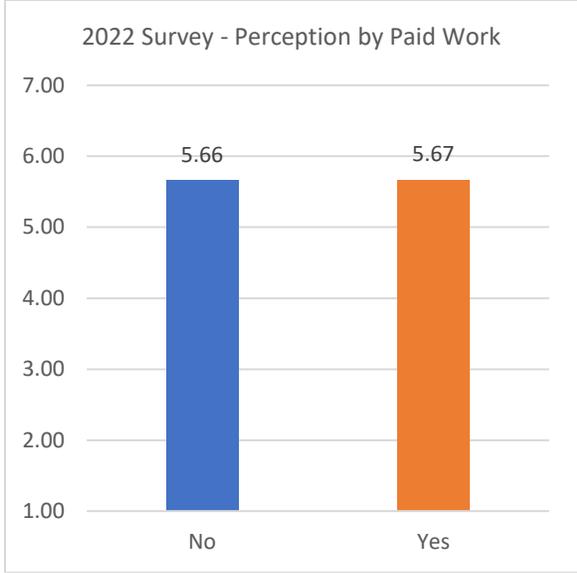




Age



Employment status



Text Anxiety

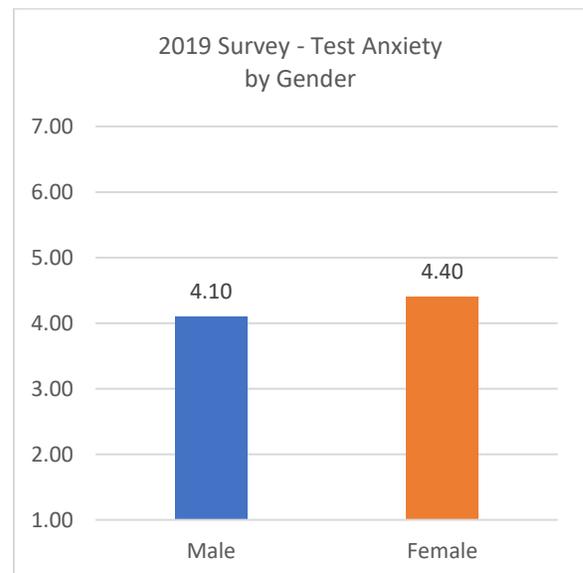
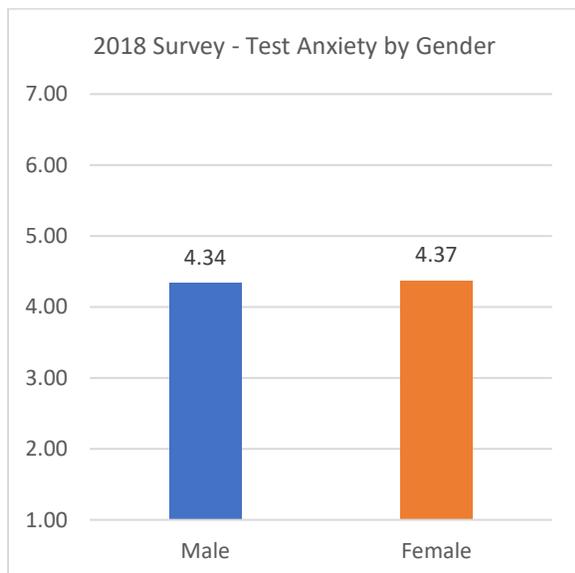
Test anxiety is a subscale of the Motivated Strategies for Learning Questionnaire (MSLQ) developed to determine the degree to which students struggle with the cognitive and emotional aspects of test anxiety [77]. Test anxiety is a single factor construct measured with five items. Test anxiety has been shown to negatively affect students' academic performance [81, 10]. In addition, this test anxiety scale has been used frequently on a wide range of students populations, and its validity and reliability evidence of acceptable [78].

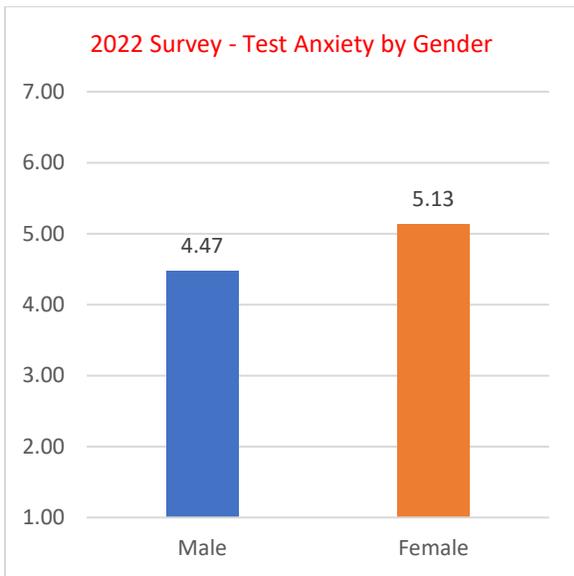
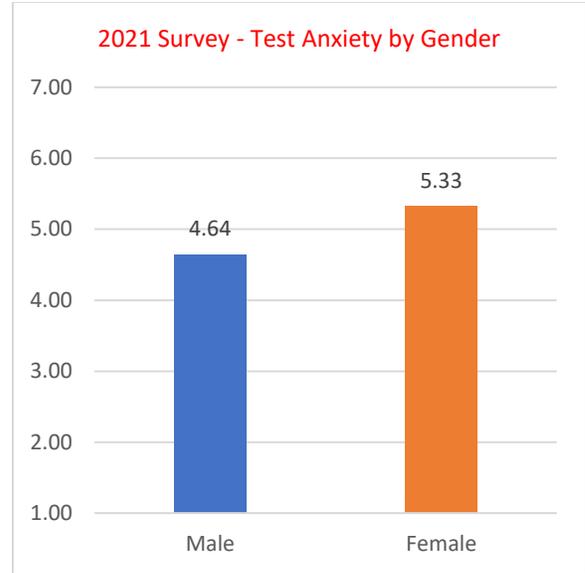
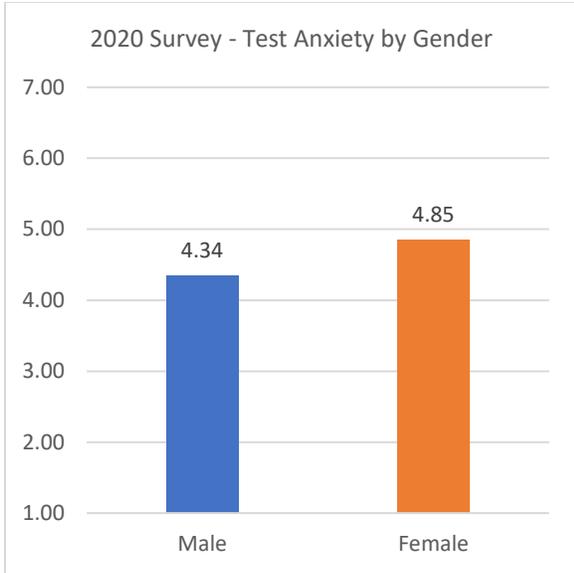
Number of items: 5

Interpretation of the scale: Higher scores on the test anxiety scale indicate that students are more anxious when they take tests

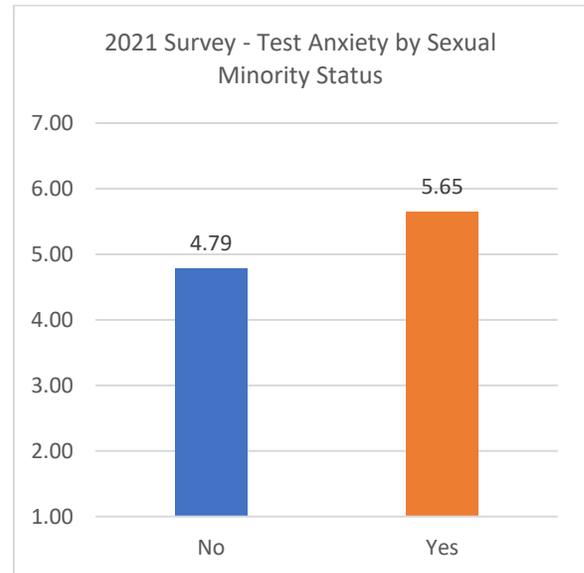
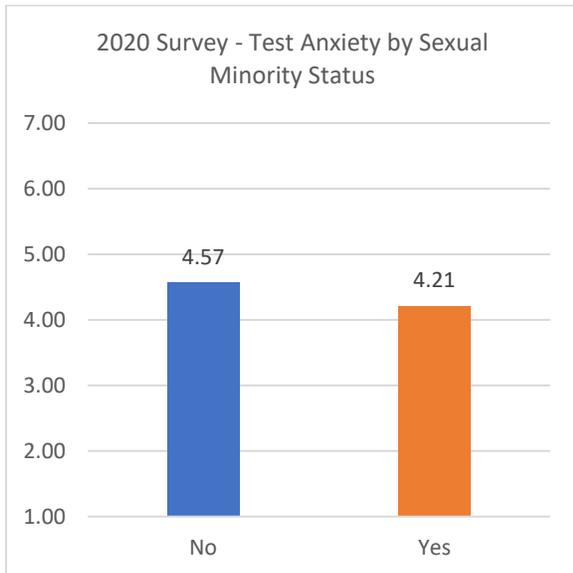
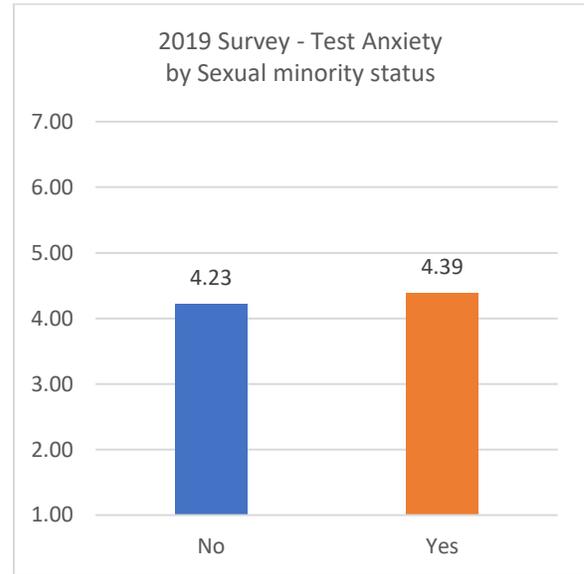
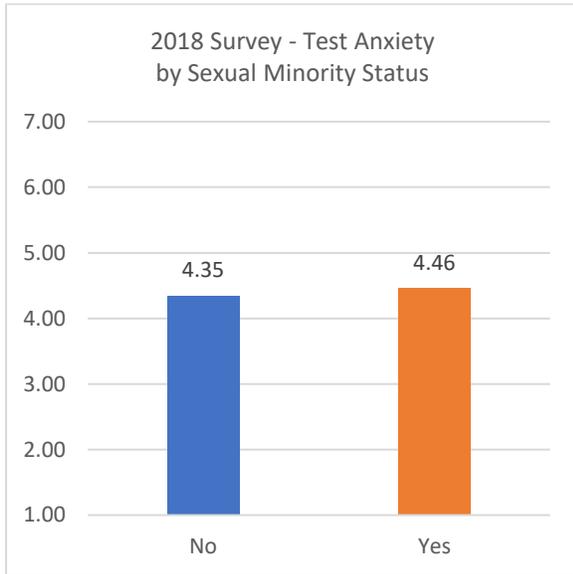
Malleability: Test anxiety may be reduced through the use of short term interventions. The most effective test anxiety interventions use a combination of study skills training and cognitive-behavioral techniques [22]. Group interventions have also produced better results than individual interventions. Proposed test anxiety interventions would initially educate students on test anxiety and its negative effects on academic performance, and subsequently train students to use specific test taking and goal setting strategies [69].

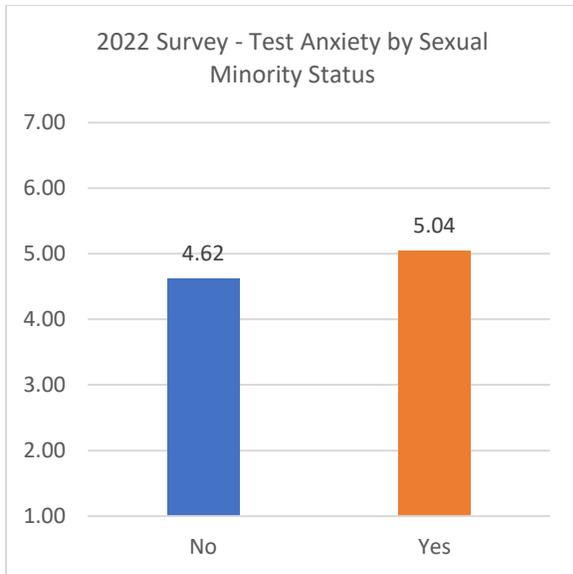
Gender



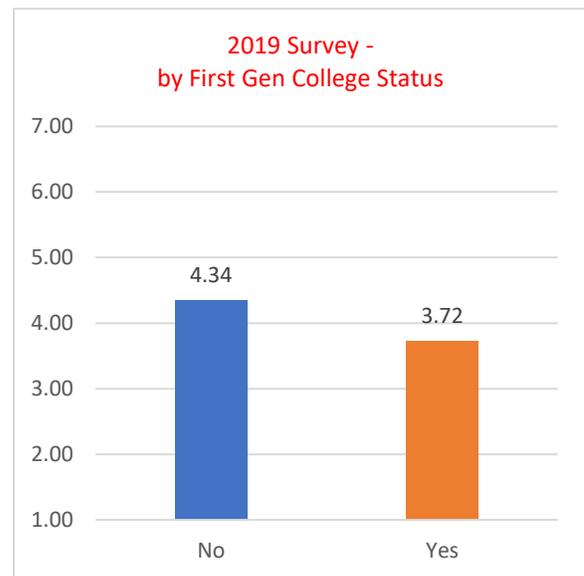
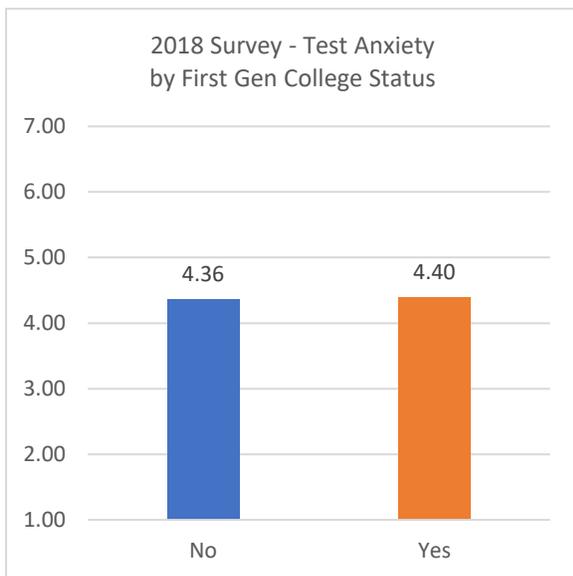


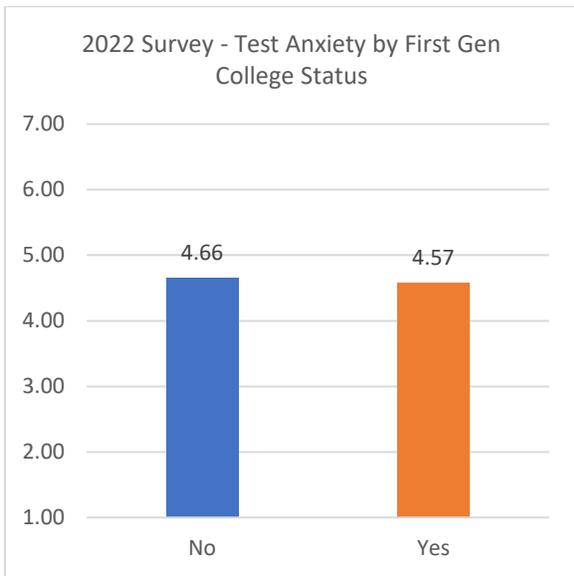
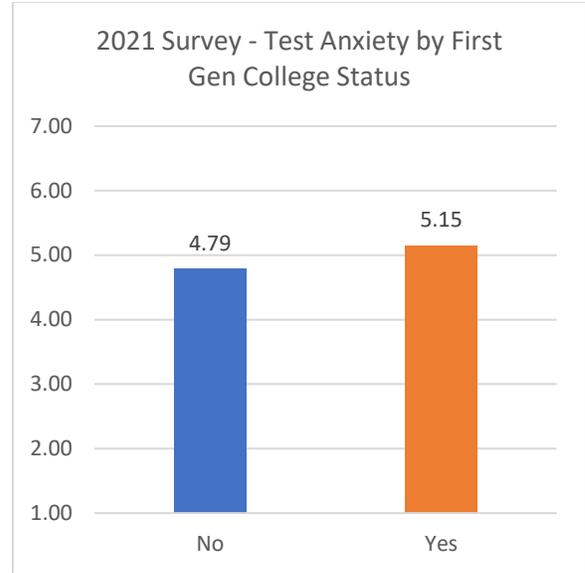
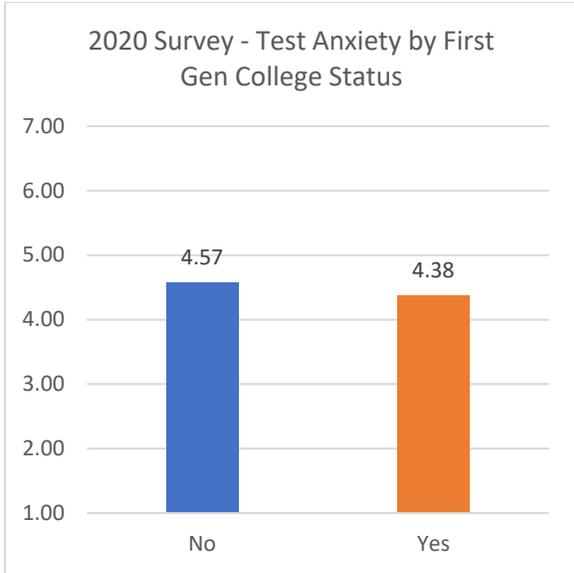
Sexual Minority Status



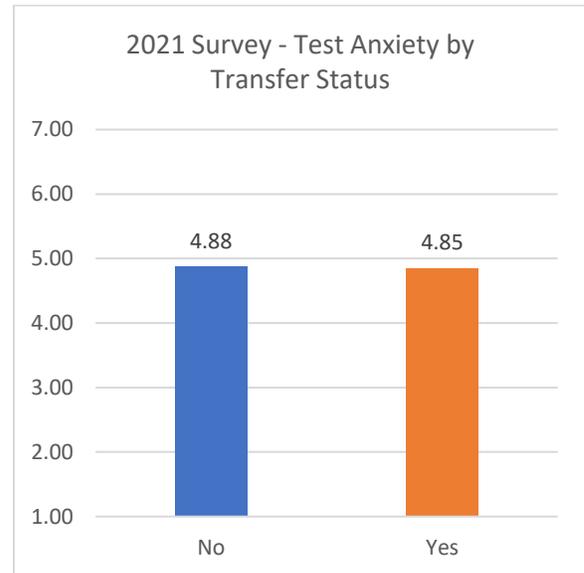
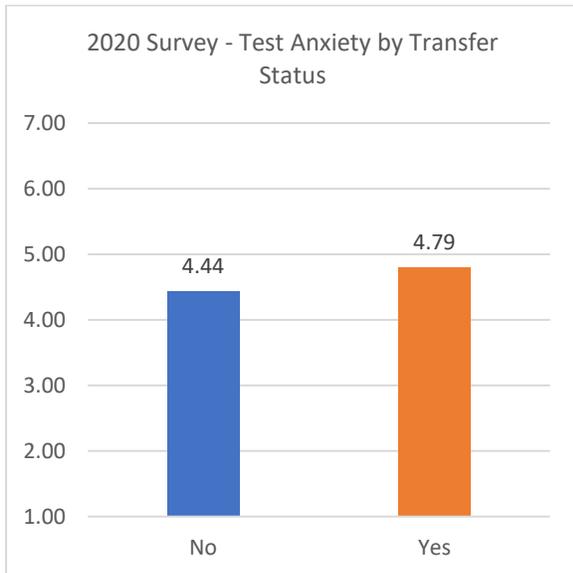
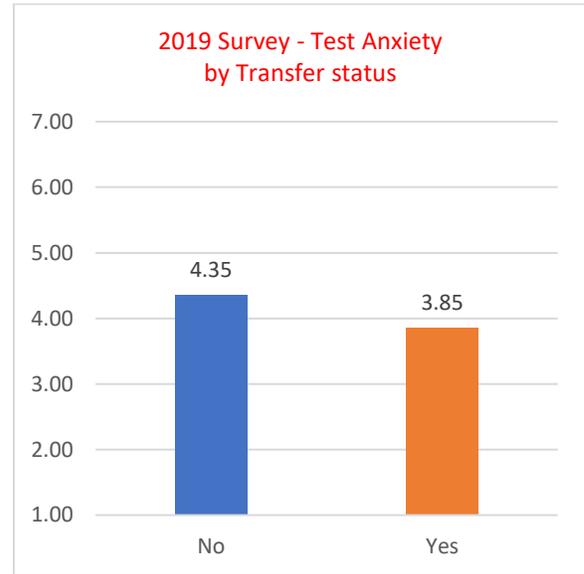
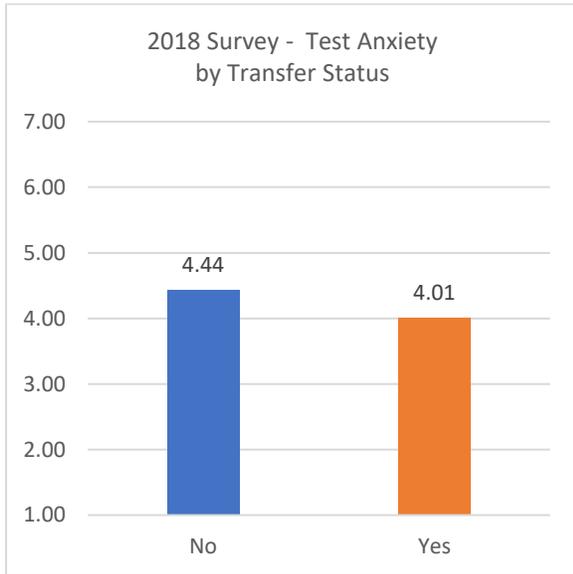


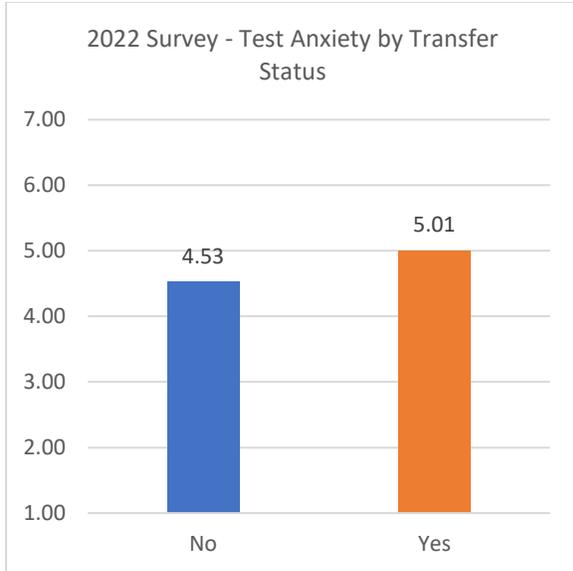
First-generation College Status



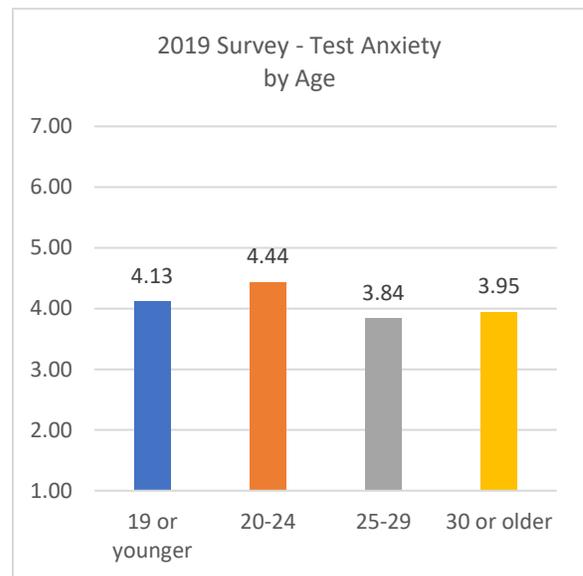
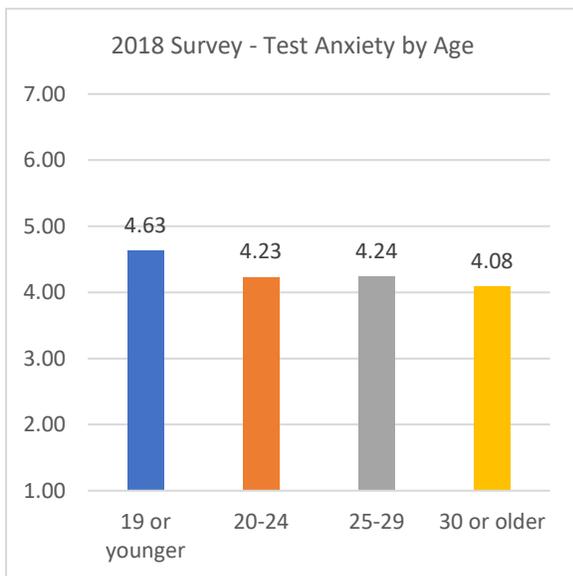


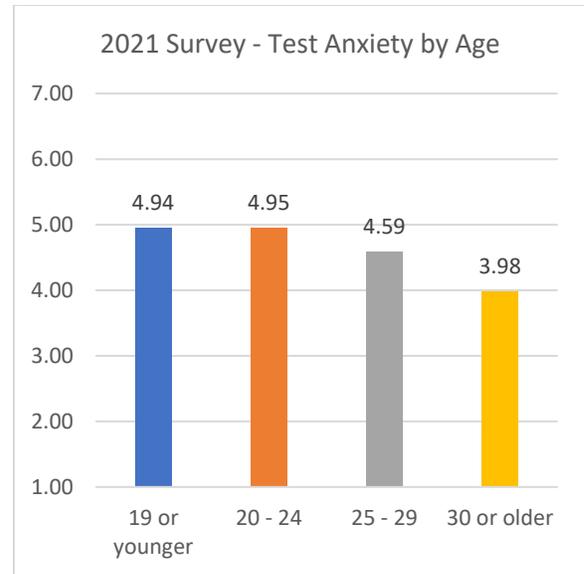
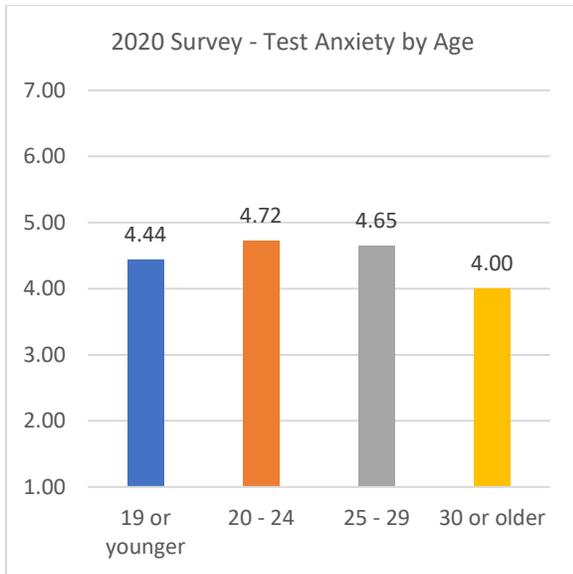
Transfer Status



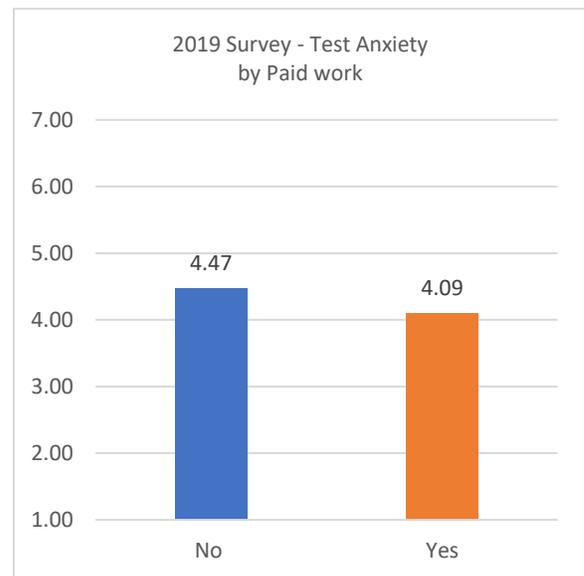
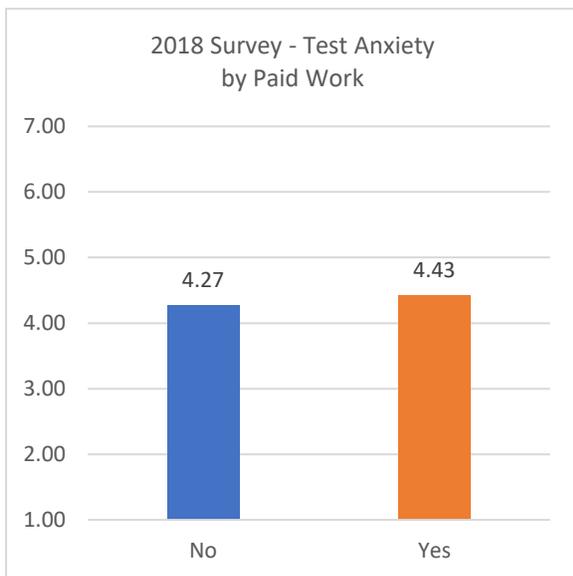


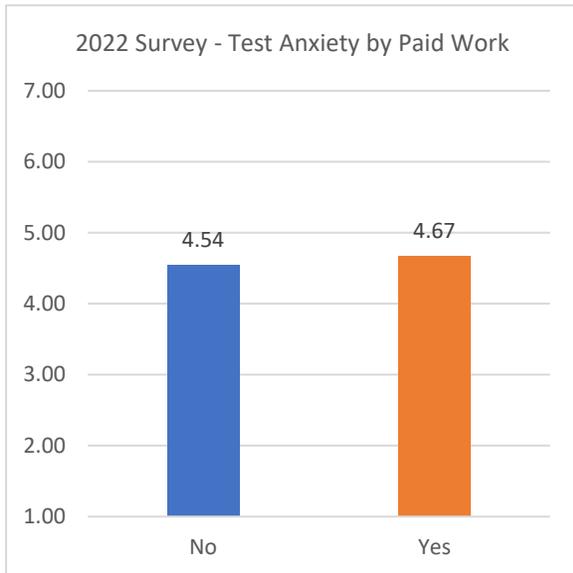
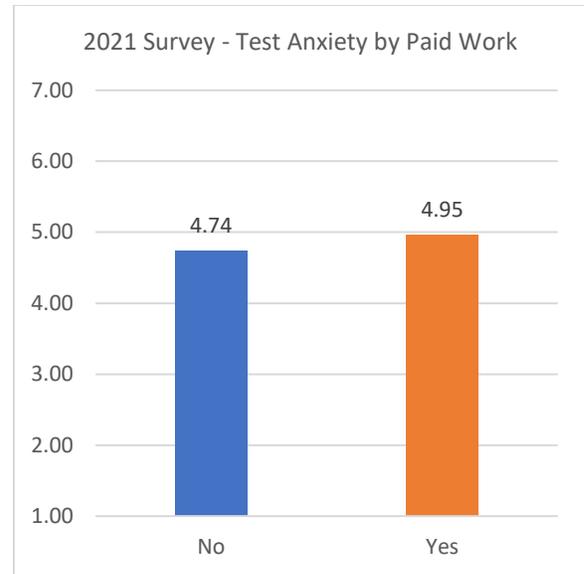
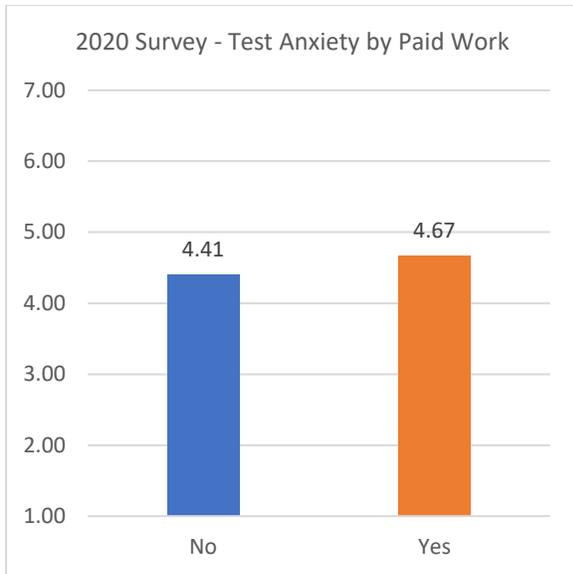
Age





Employment status





Time and Study Environment

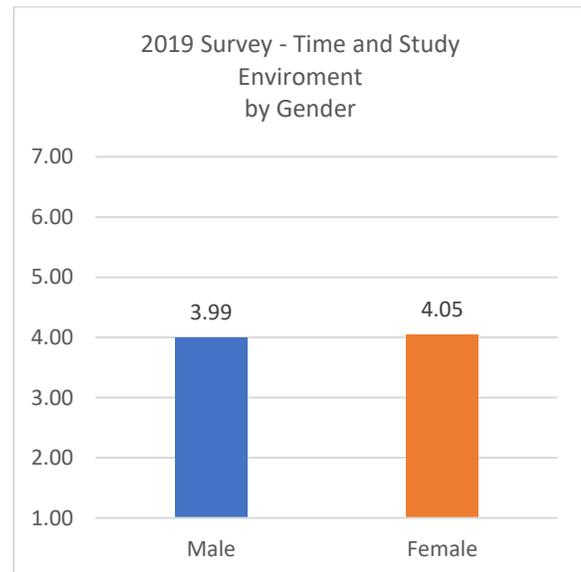
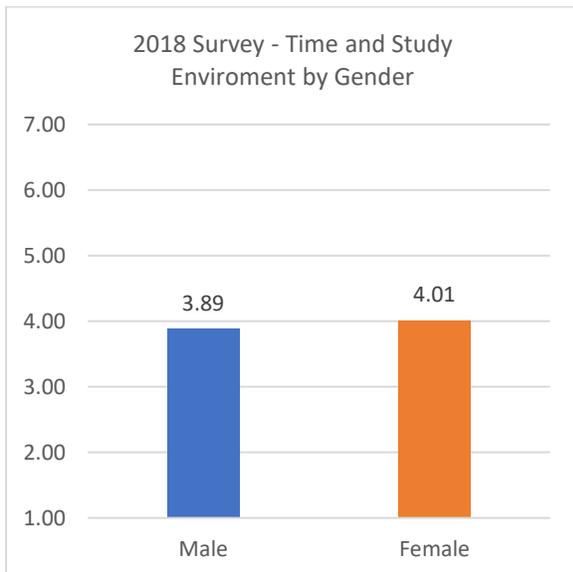
Time and study environment is another subscale of the Motivated Strategies for Learning Questionnaire (MSLQ) developed to measure the extent to which students can effectively manage and regulate their time and location set aside for studying [77]. Time and study environment is a single factor construct measured with four items. Each item is a statement (e.g., "I find it hard to stick to a study schedule"). Time and study environment has been shown to positively affect student academic performance [12], and has acceptable validity and reliability evidence. [78].

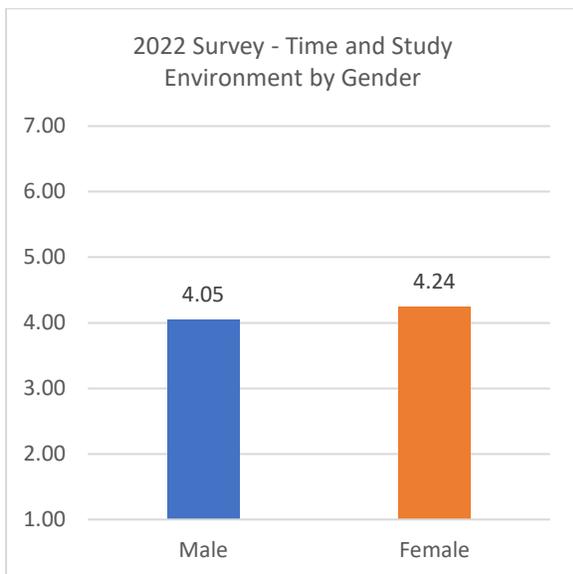
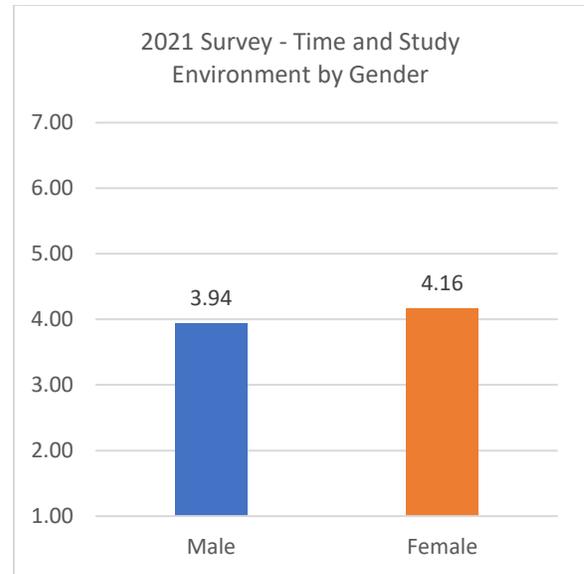
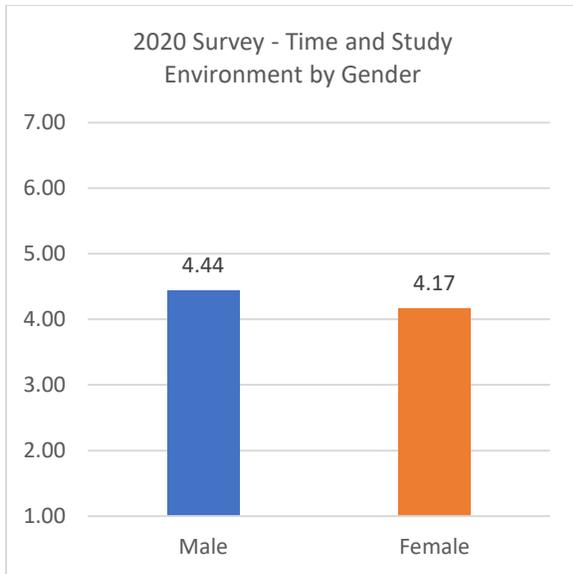
Number of items: 4

Interpretation of the scale: Higher scores on the time and study environment scale indicate that students effectively manage their time and location for studying.

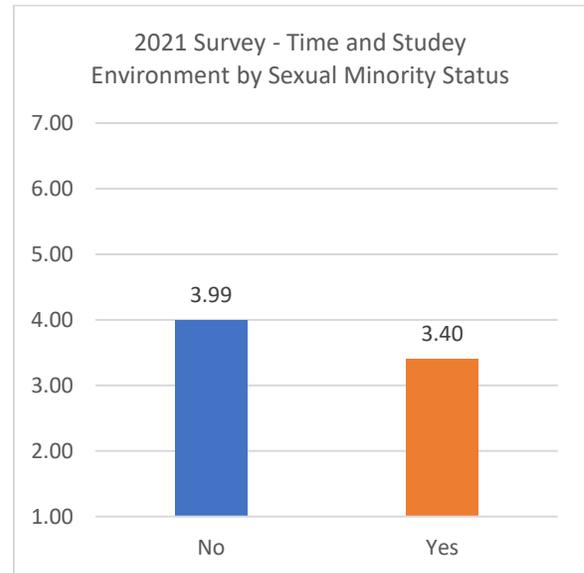
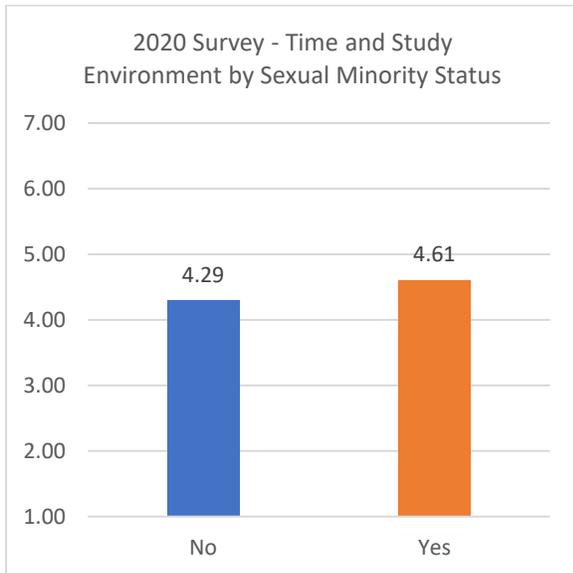
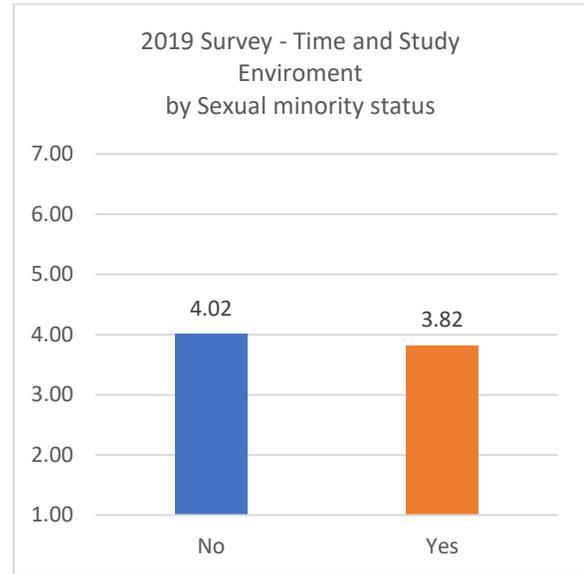
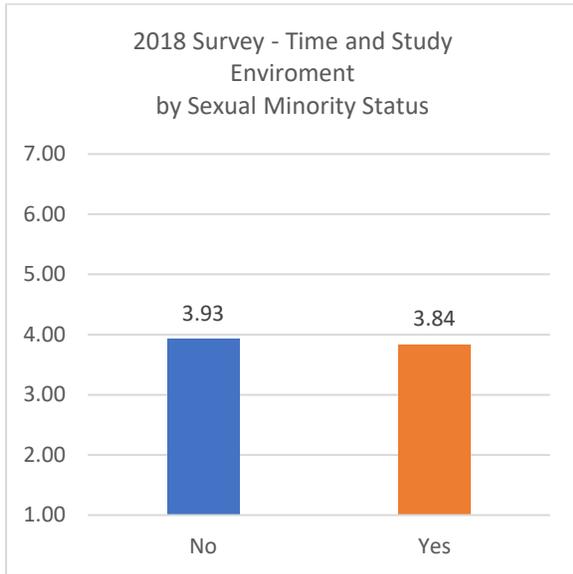
Malleability: A number of self-regulation, motivational, and skill-based interventions have been shown to improve study skills and habits in students, and ultimately improve academic performance [42]. Of such interventions, those that teach the use of structural aids - such as advanced organizers - had the strongest positive affect on both study skills and academic performance. Study skill interventions have proven to be most effective in the first year of college or earlier [54].

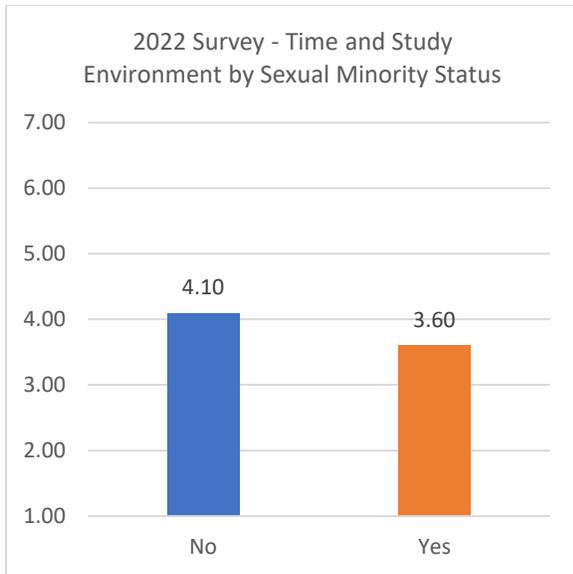
Gender



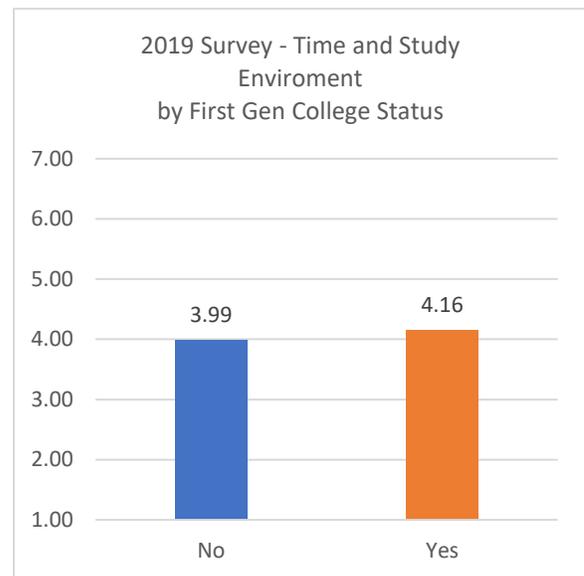
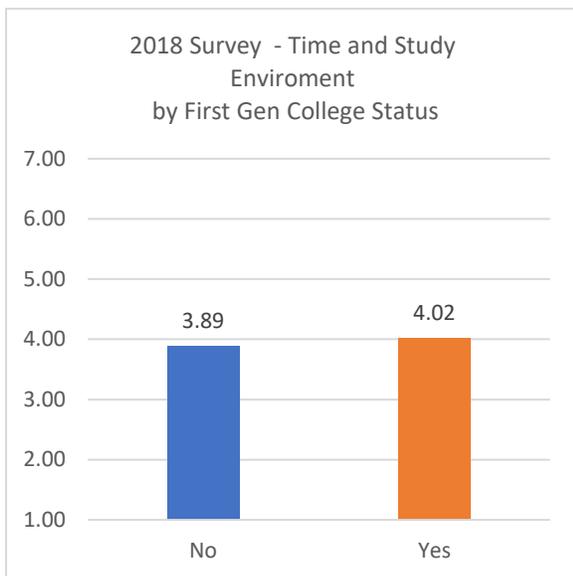


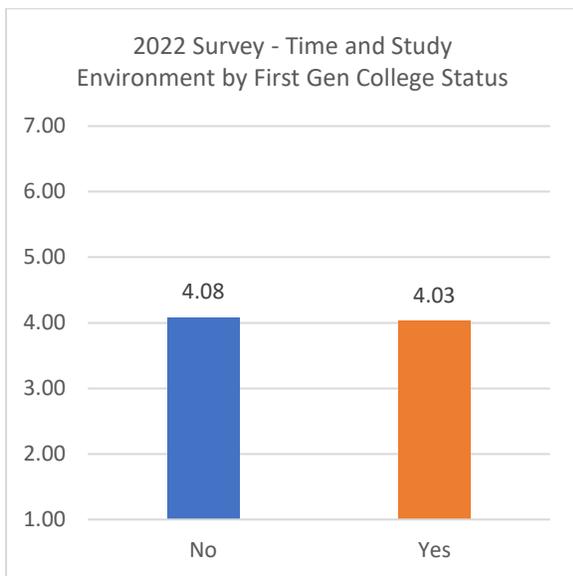
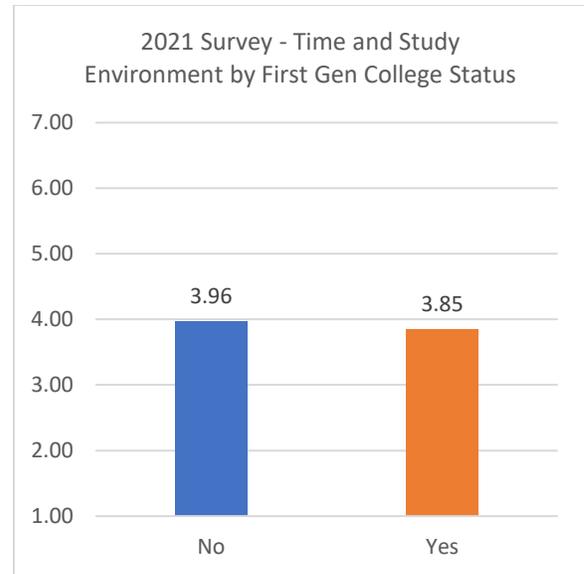
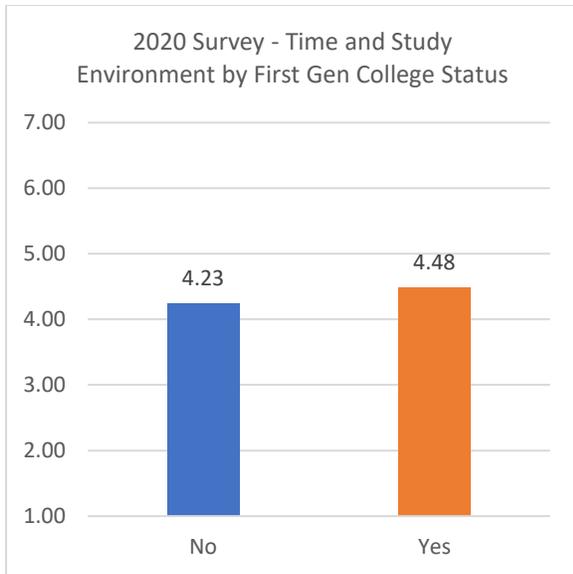
Sexual Minority Status



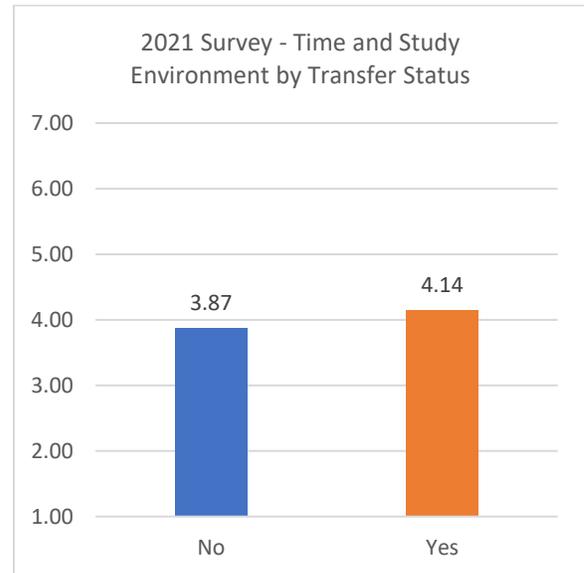
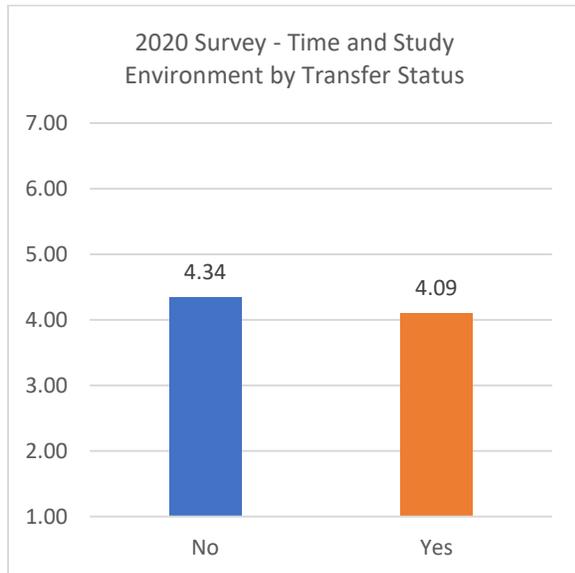
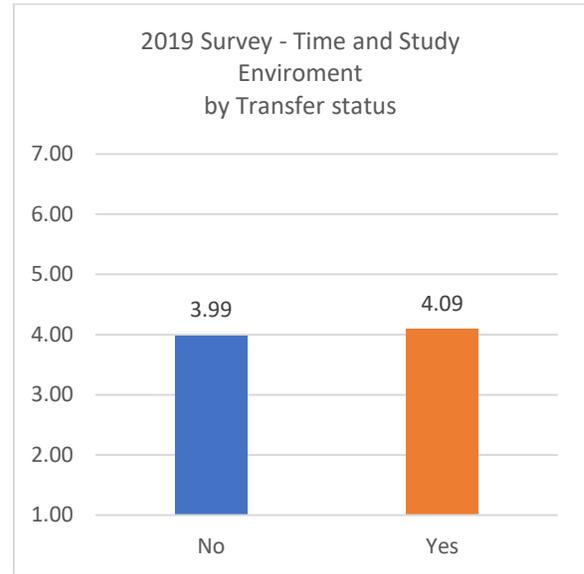
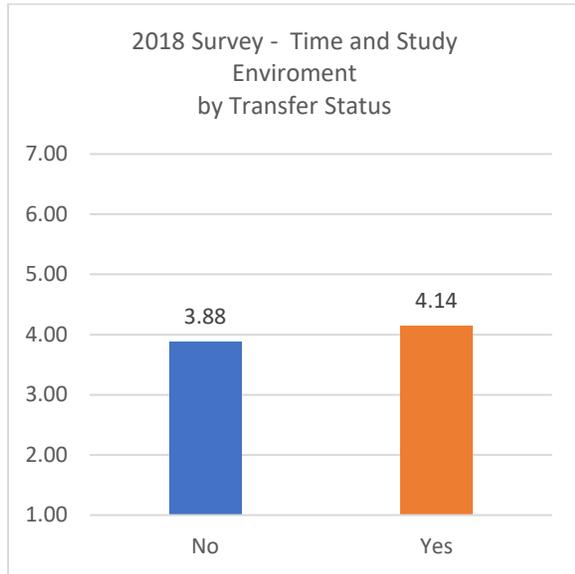


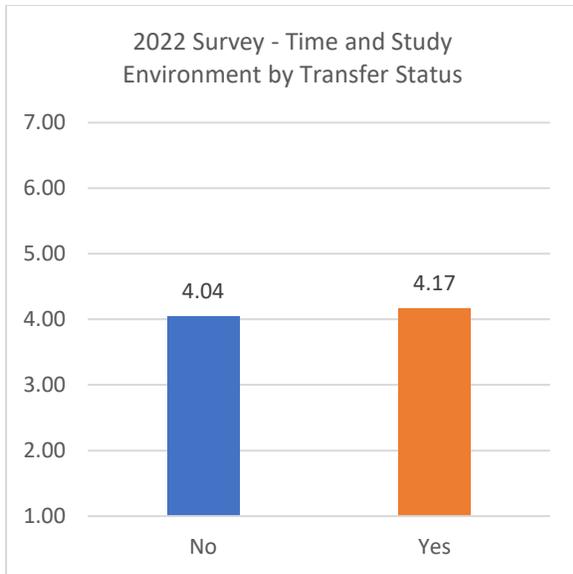
First-generation College Status



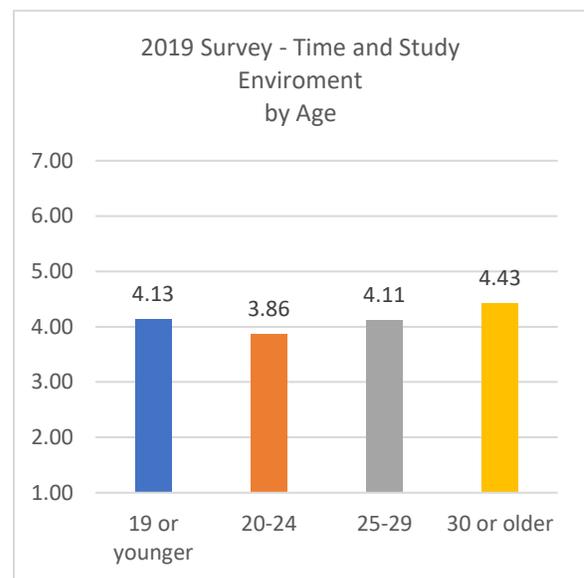
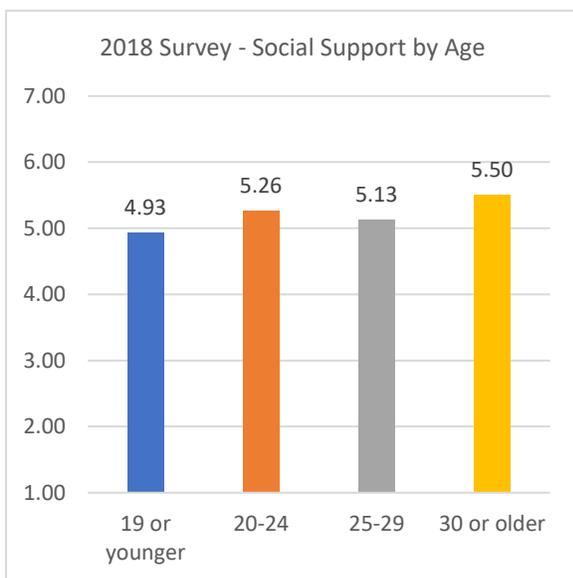


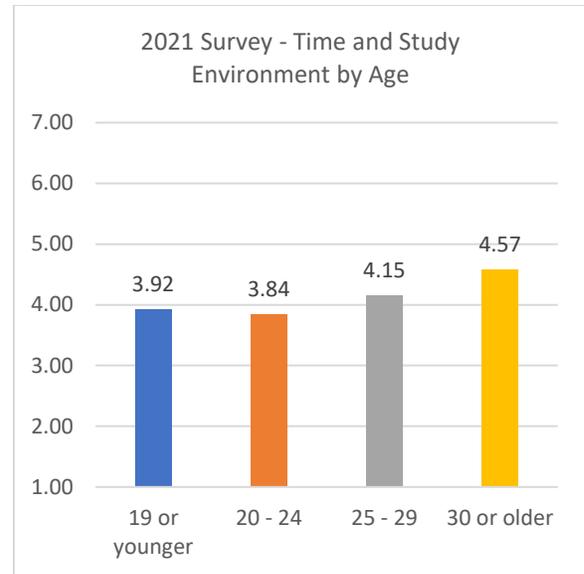
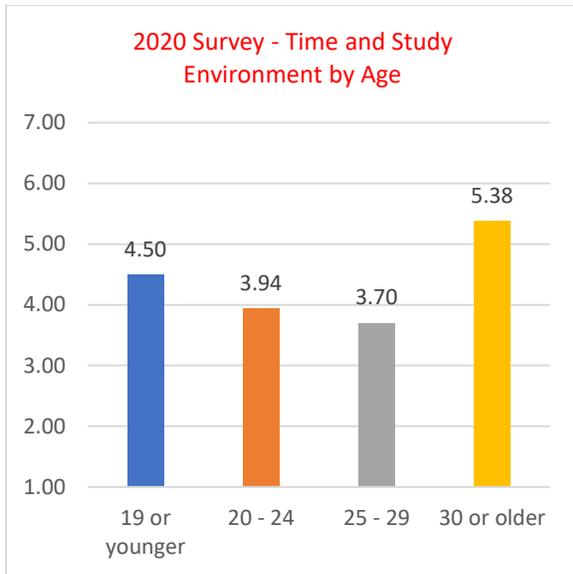
Transfer Status



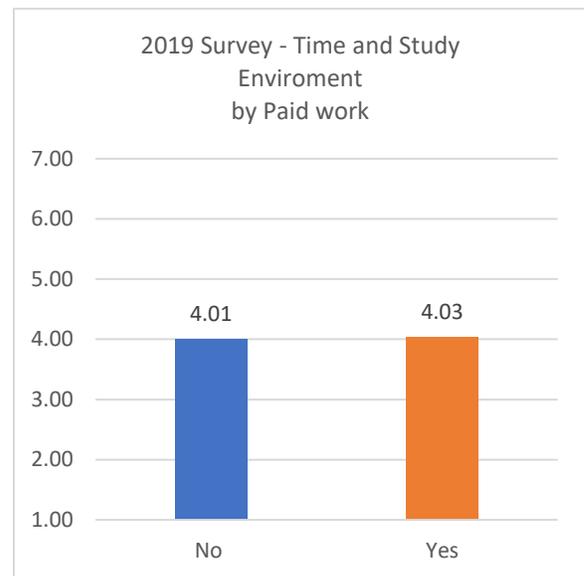
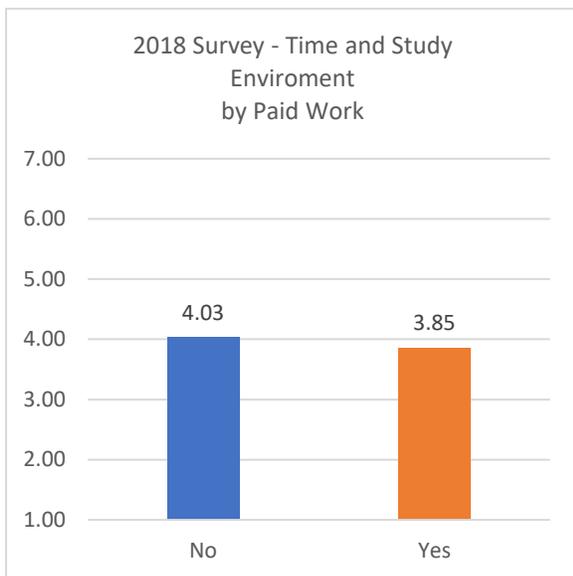


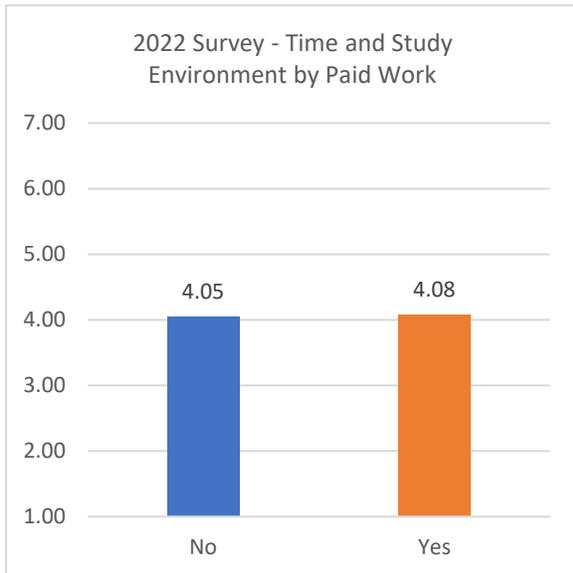
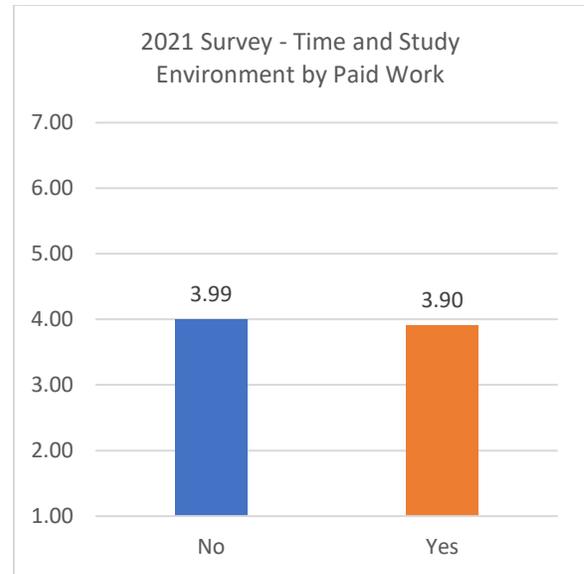
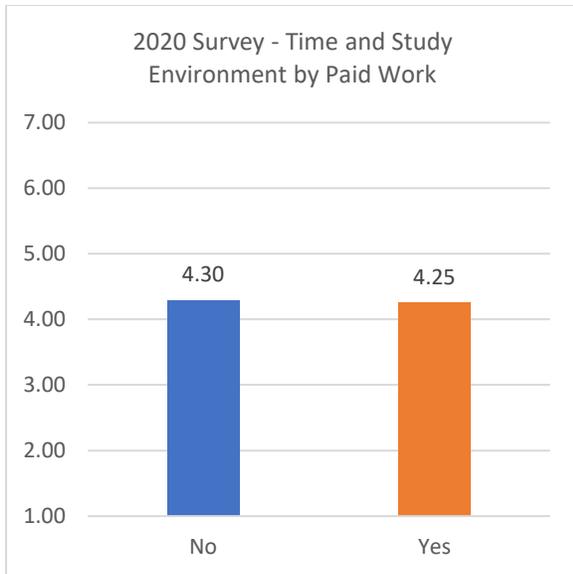
Age





Employment status





Perceptions of faculty caring

The perceptions of faculty caring scale characterizes faculty caring in two ways [46]. The empathetic understanding scale asks questions such as "I feel that a faculty member really tried to understand my problem when I talked about it", and the perceived faculty support scale asks questions like "If I had a reason, I would feel comfortable seeking help from a faculty member outside of class time (i.e., during office hours, etc.)." This scale relates to a sense of belonging by focusing more on how faculty shape belonging. Our recent research shows a moderate correlation between the perception of faculty caring and engineering belongingness [84]. This research suggests that the two scales are, although correlated, indeed different. Overall, students who perceive they are a member of the academic community recognized and valued by the faculty generally have a higher sense of belonging [46]. A supportive classroom environment is linked to academic achievement mediated by belonging, self-efficacy, and engagement [101].

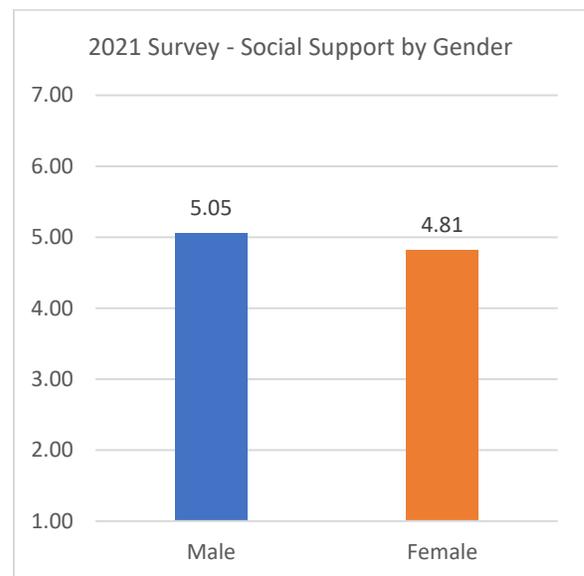
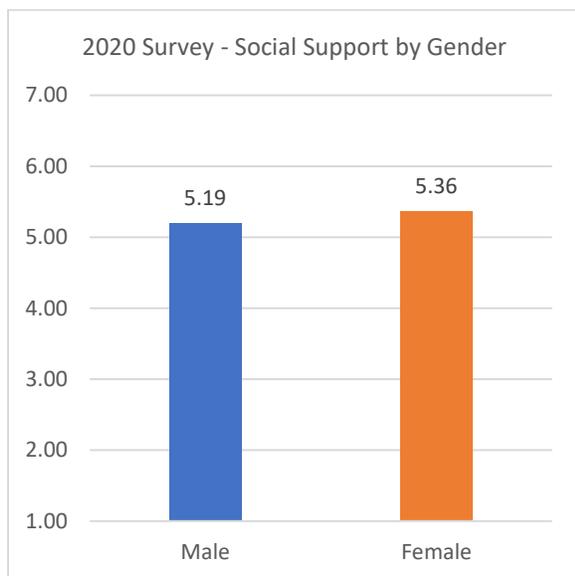
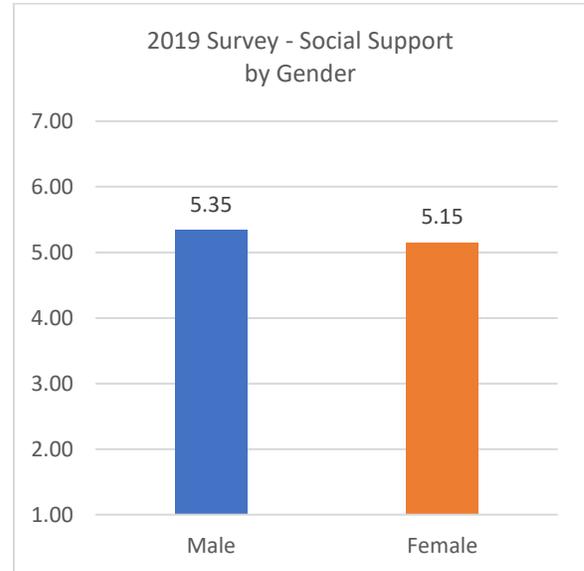
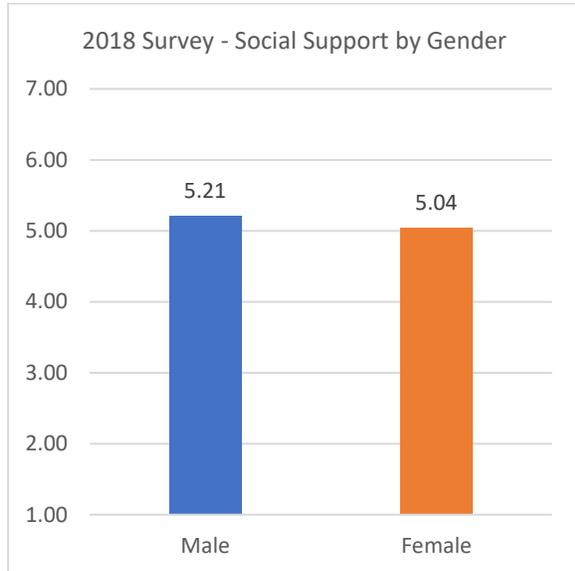
Number of items: 5

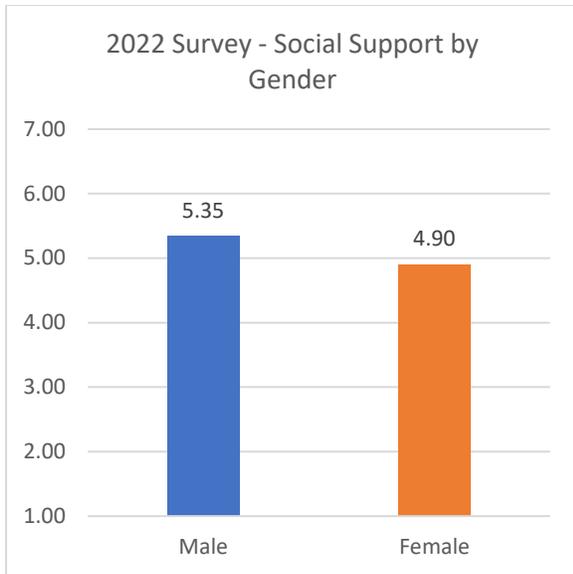
Interpretation of the scale: Higher scores indicate that students perceive greater levels of faculty caring and support

Malleability: Perceptions of faculty caring may change over both short and long time periods and be impacted through interventions [95]. Research shows that students who perceive that they have even one positive relationship with a faculty member are less likely to leave their major or institution. Additionally, faculty who communicate that they care through availability during office hours, make students feel comfortable when discussing personal problems, and increase overall ease while discussing career goals are perceived to be more caring by students [47]. Students also perceive more faculty caring when their faculty communicate an openness to discussing difficult topics and are available can help promote success for all students [72].

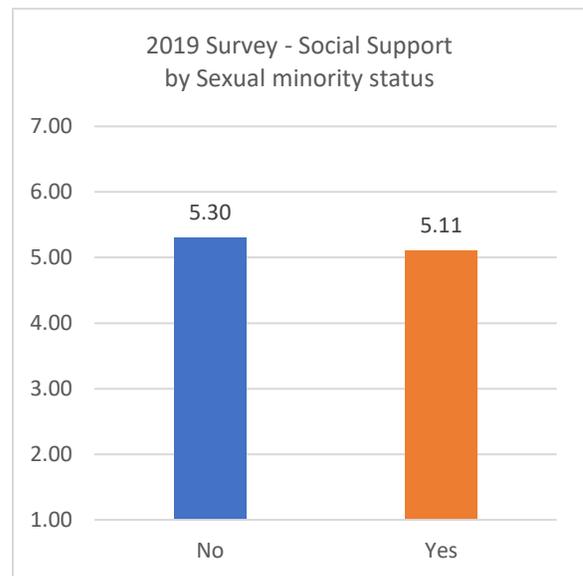
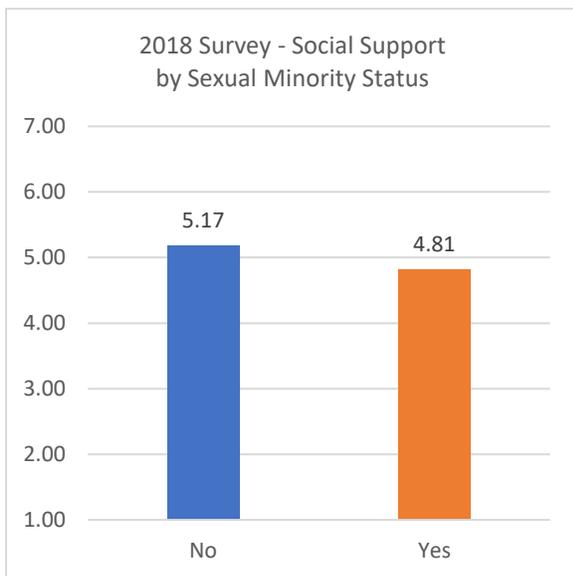
1) Social Support

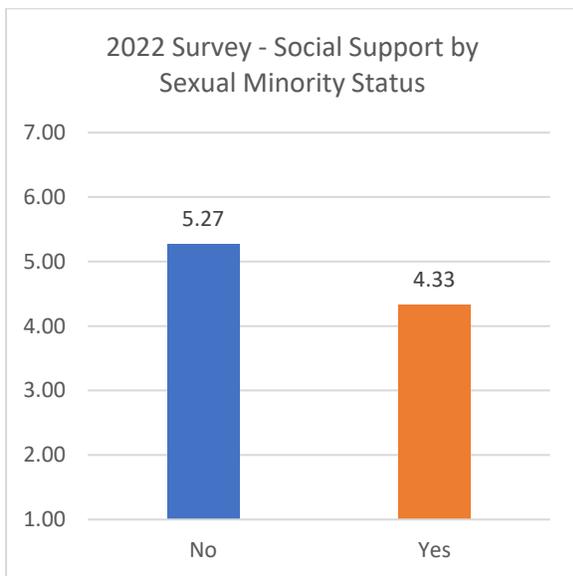
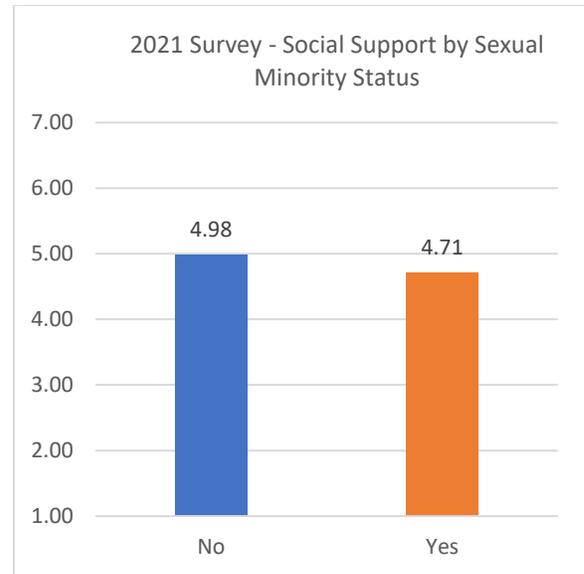
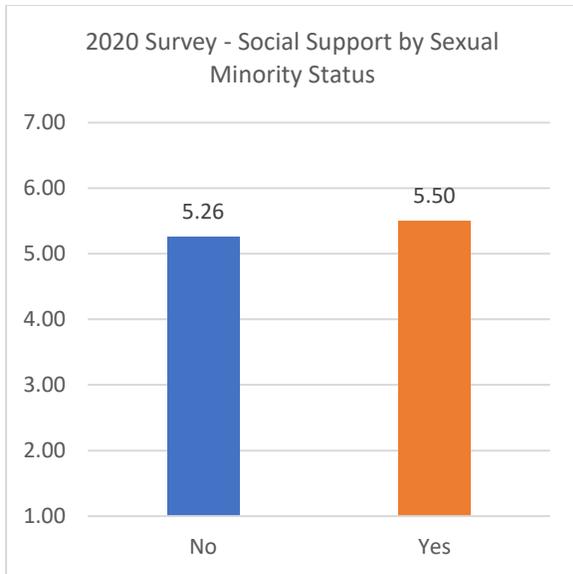
Gender



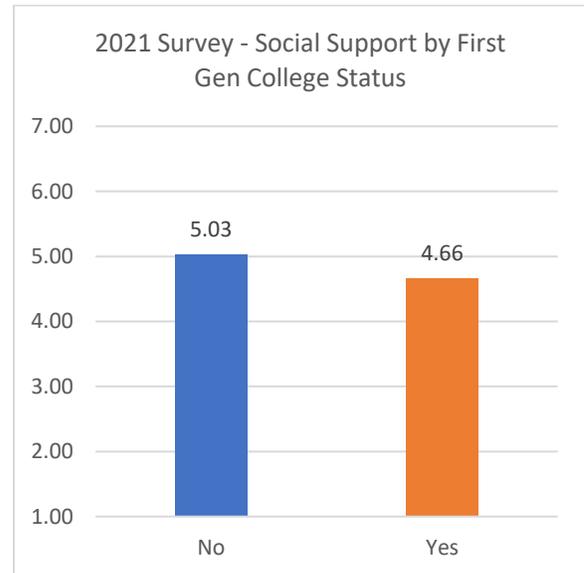
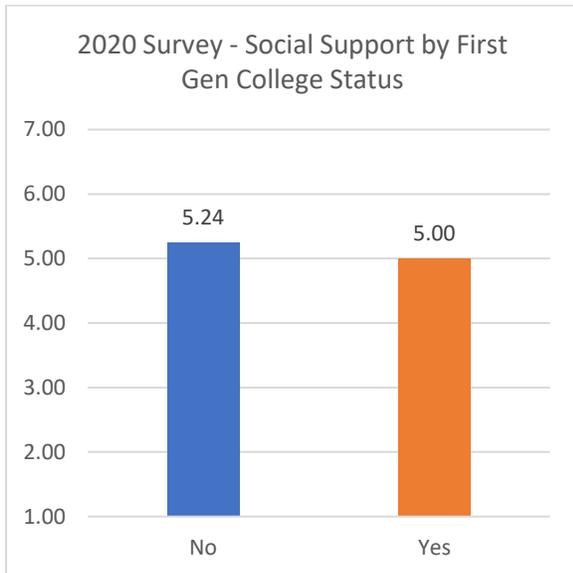
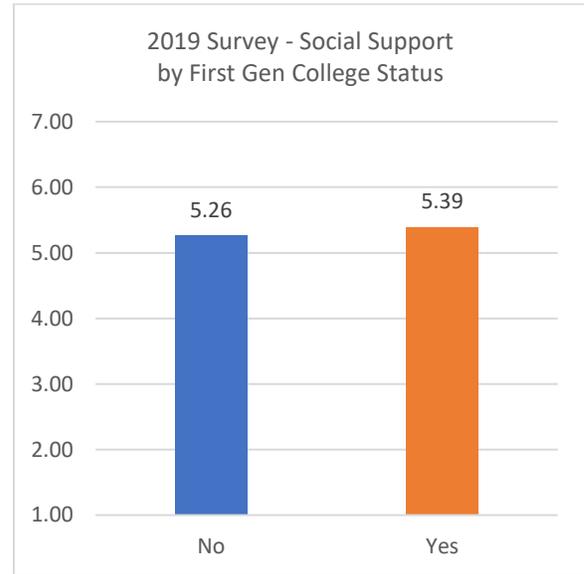
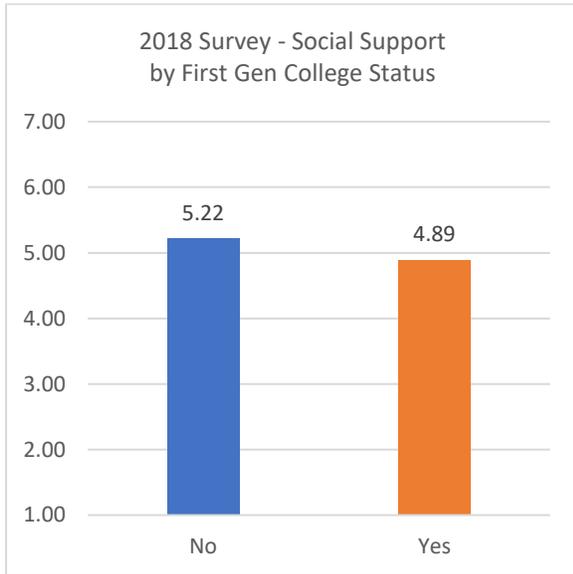


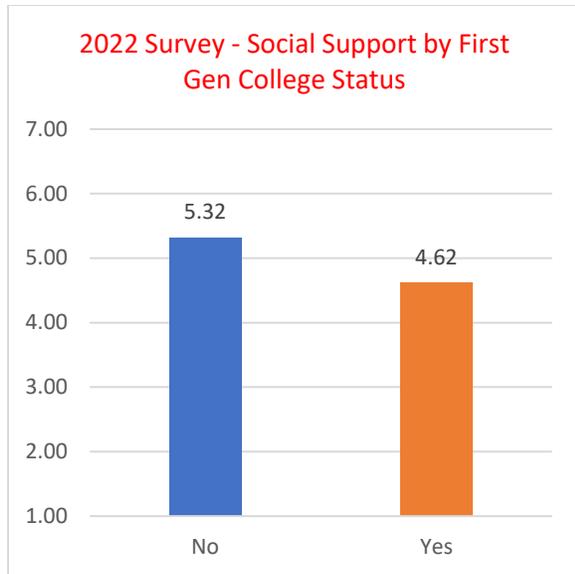
Sexual Minority Status



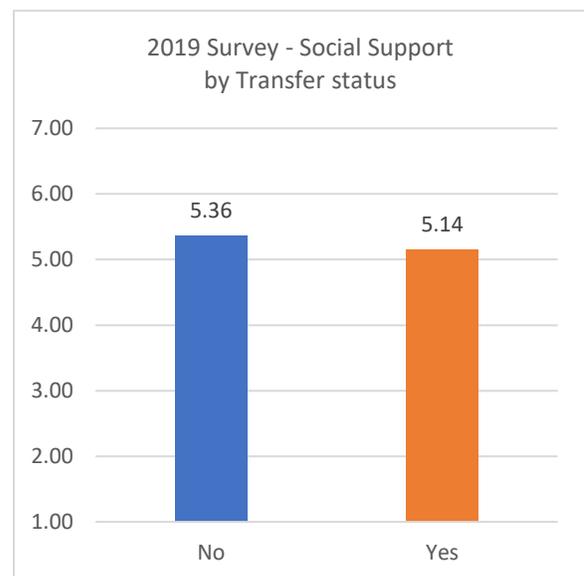
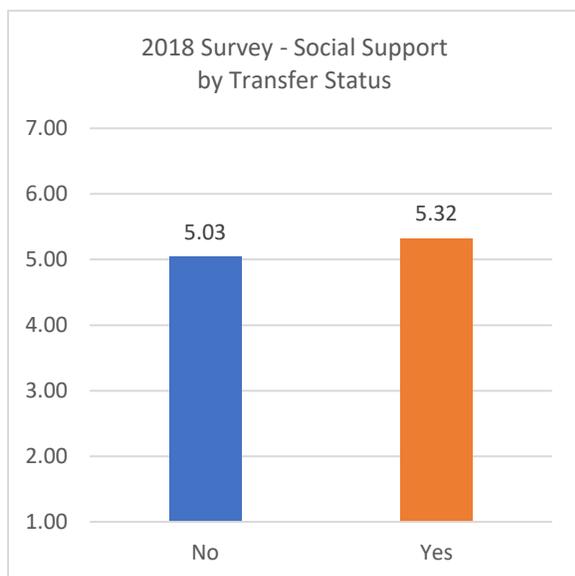


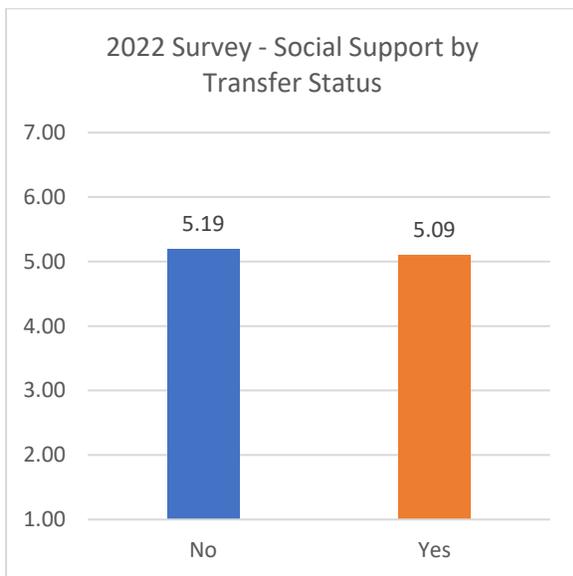
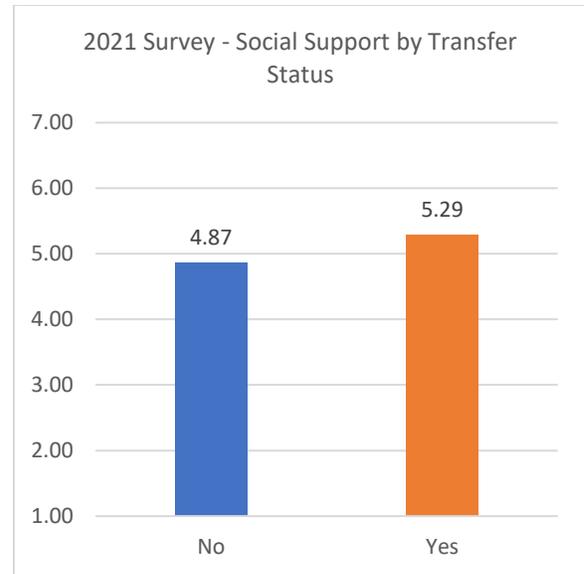
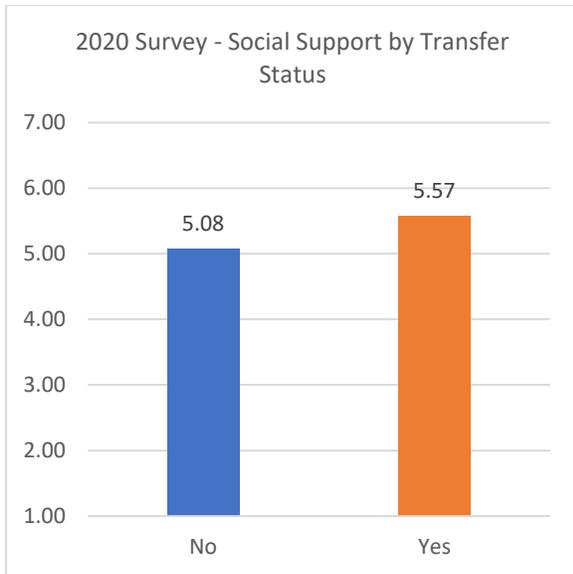
First-generation College Status



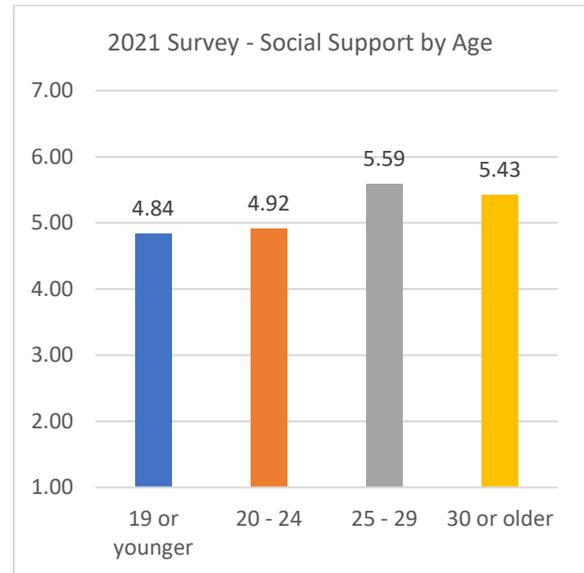
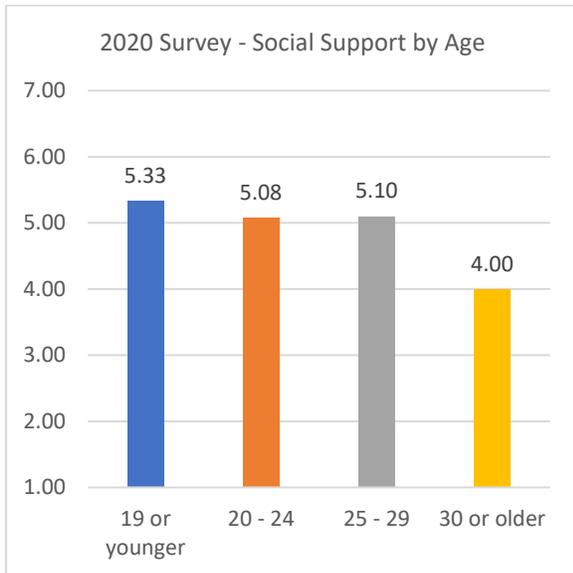
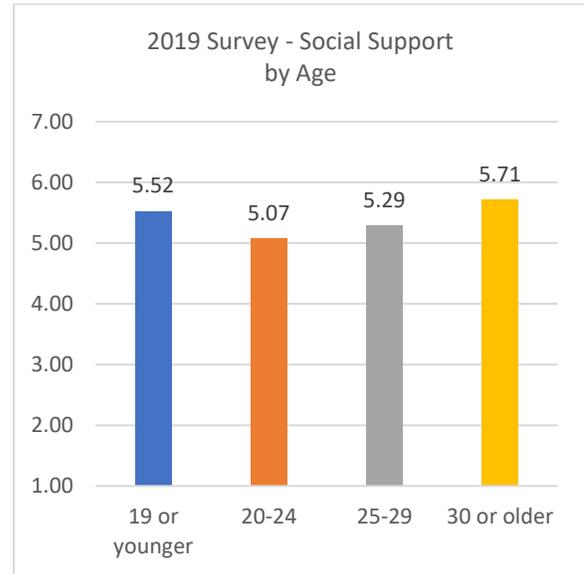
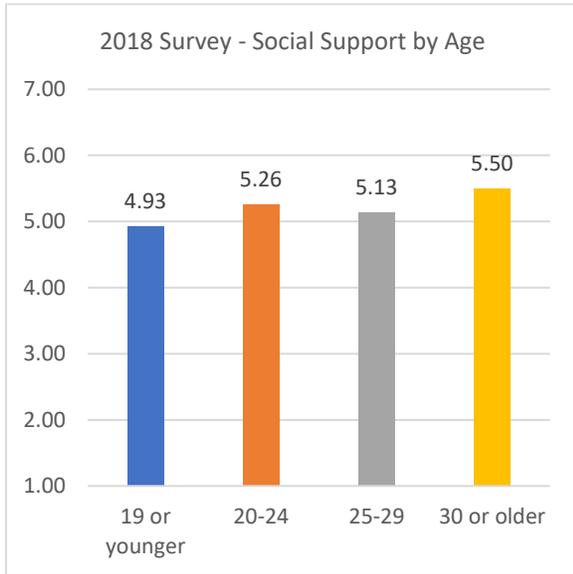


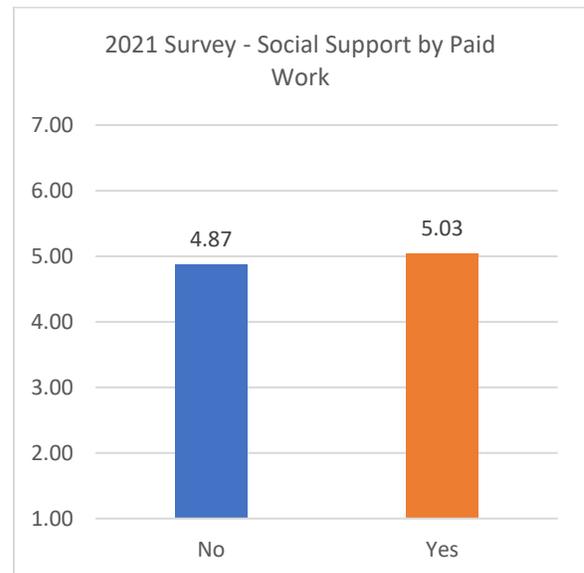
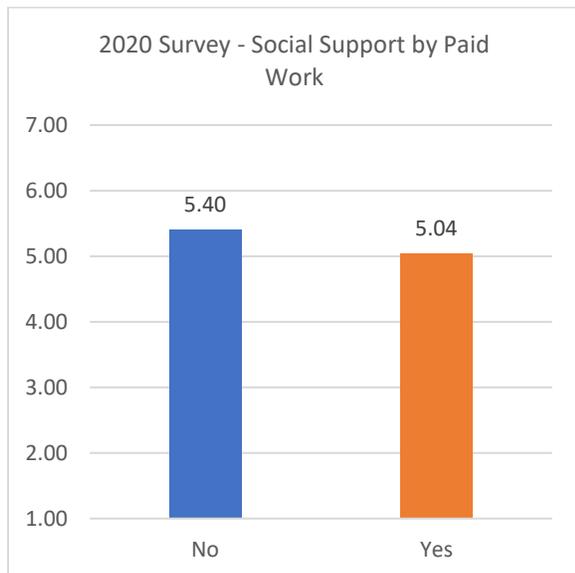
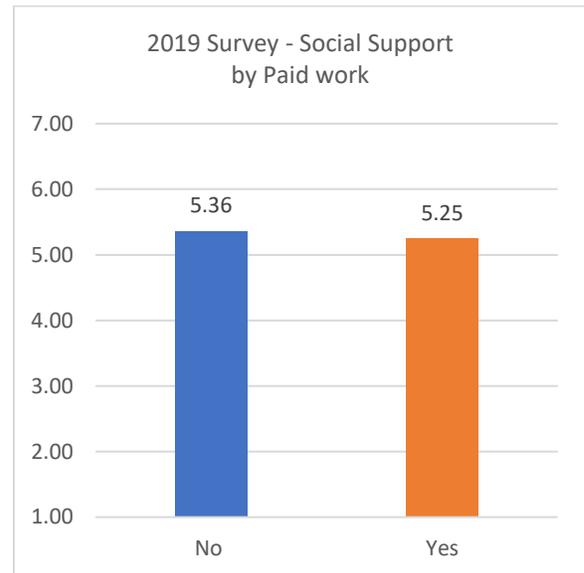
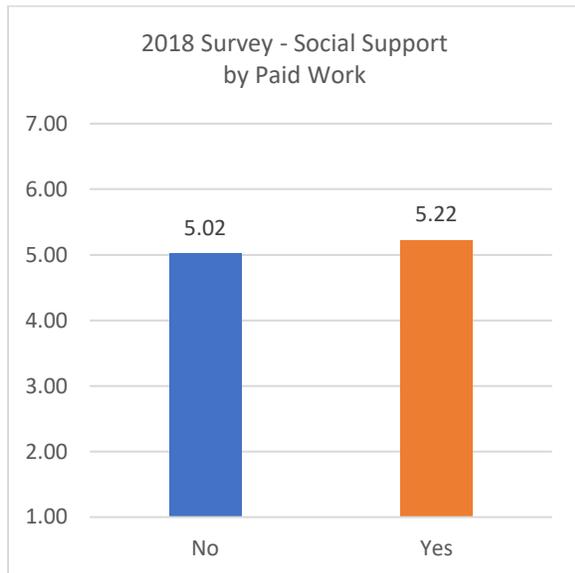
Transfer Status

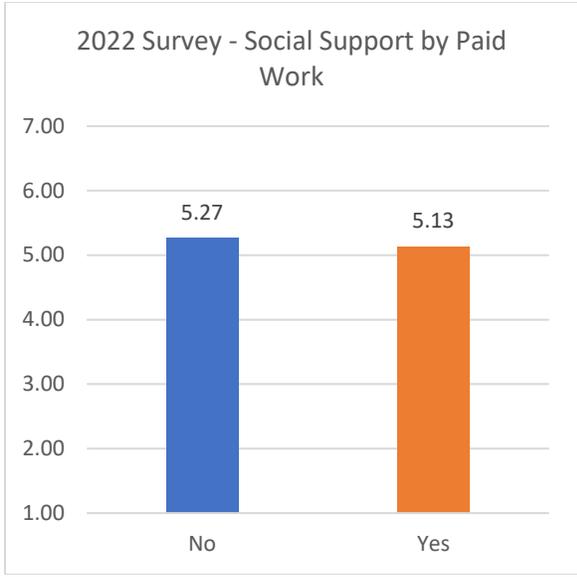




Age

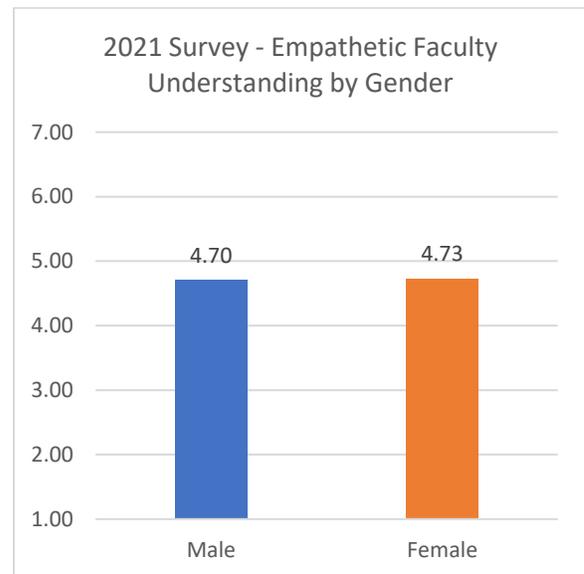
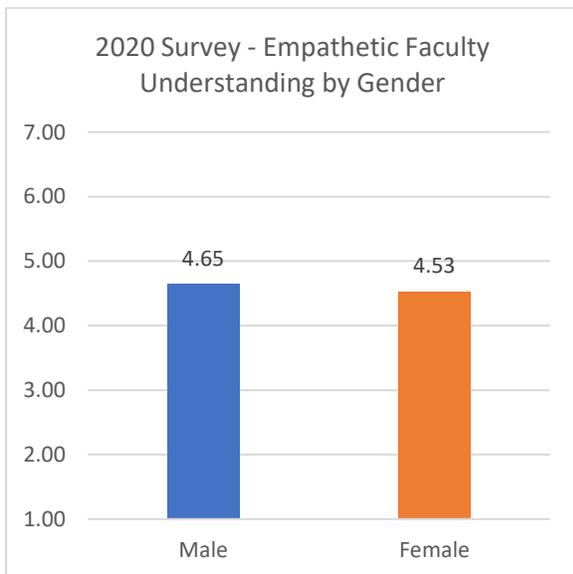
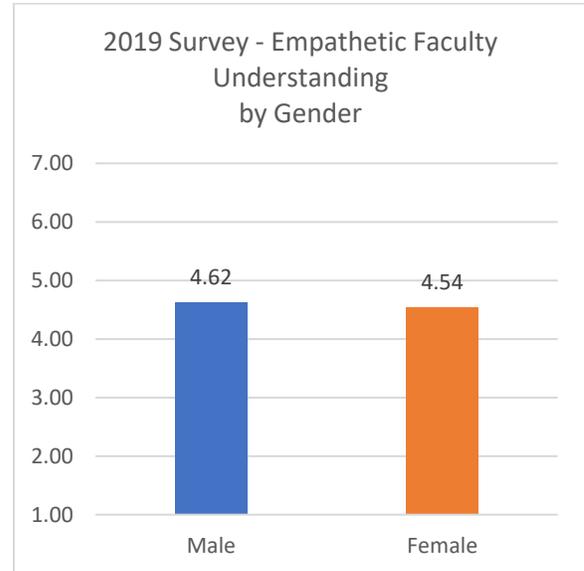
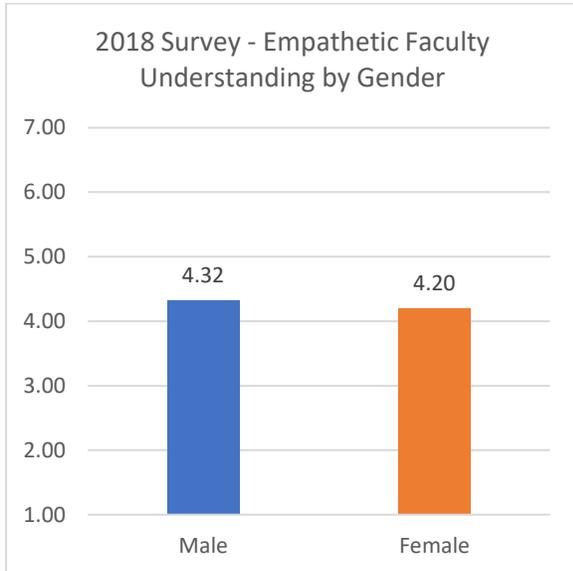


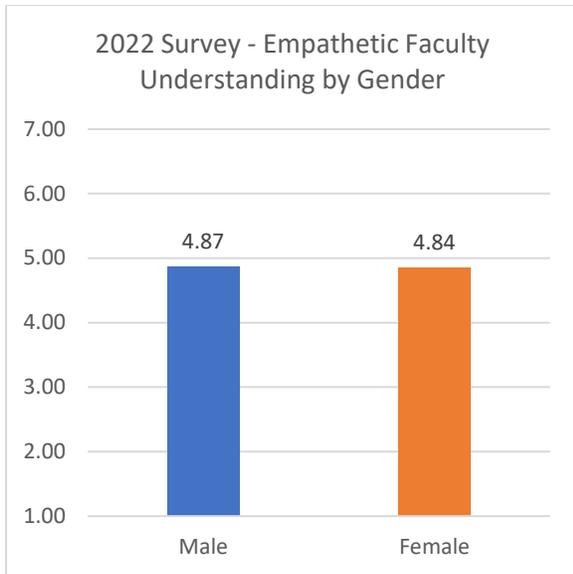
Employment status



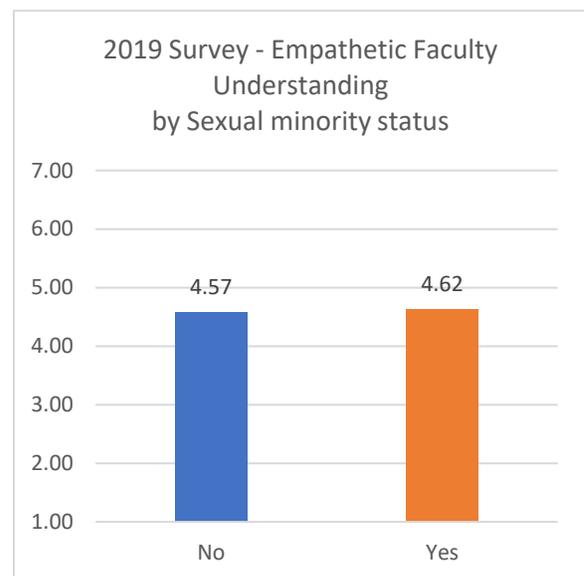
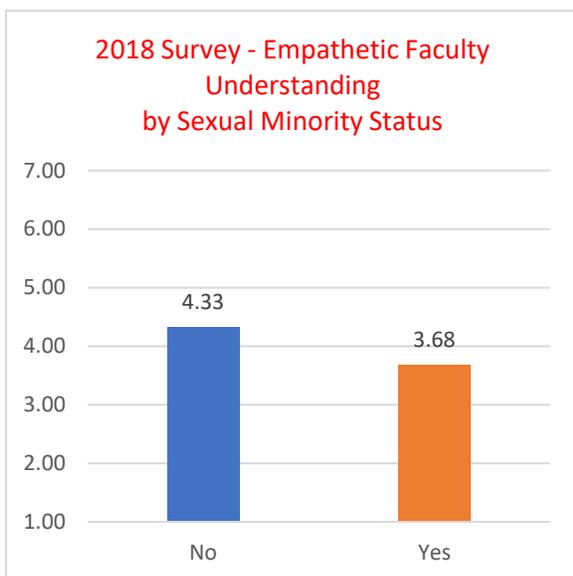
2) Empathetic Faculty Understanding

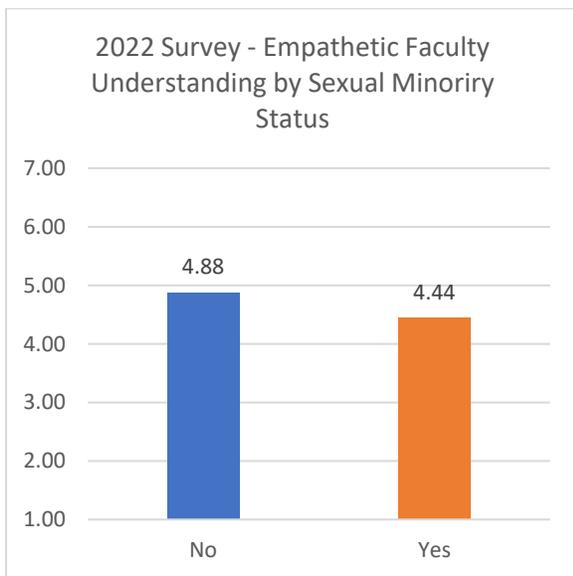
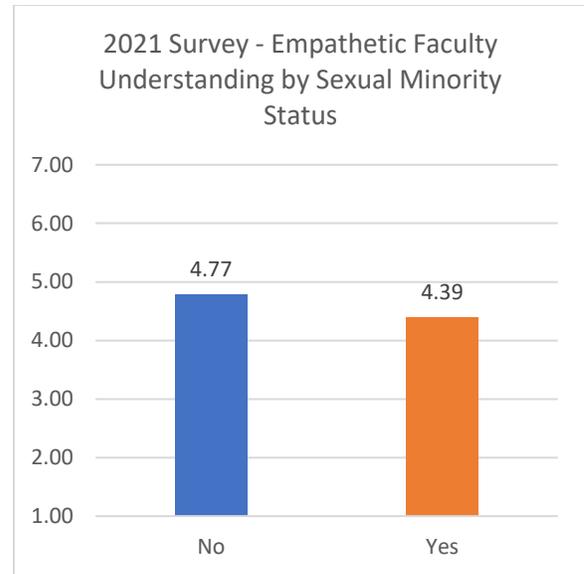
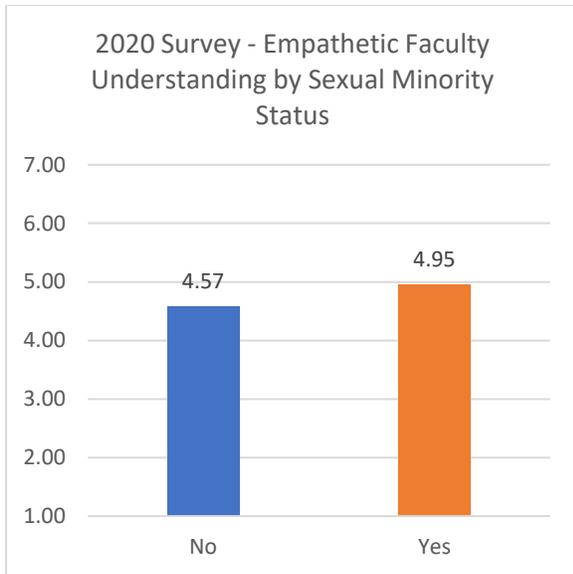
Gender



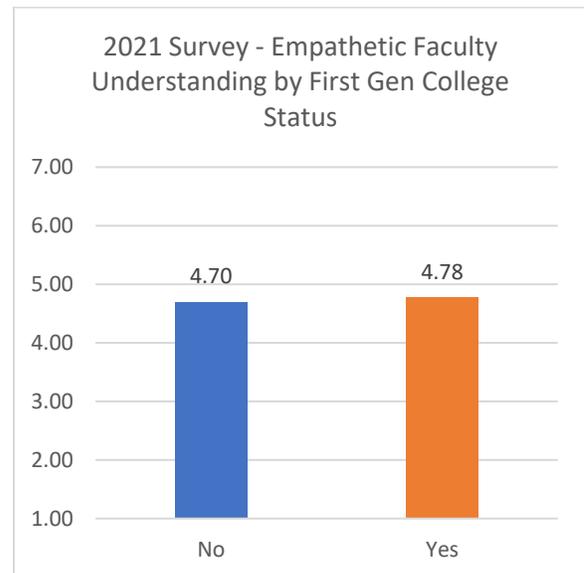
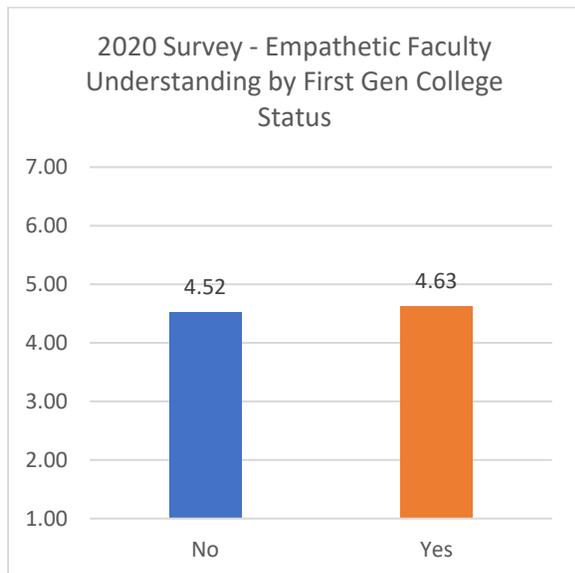
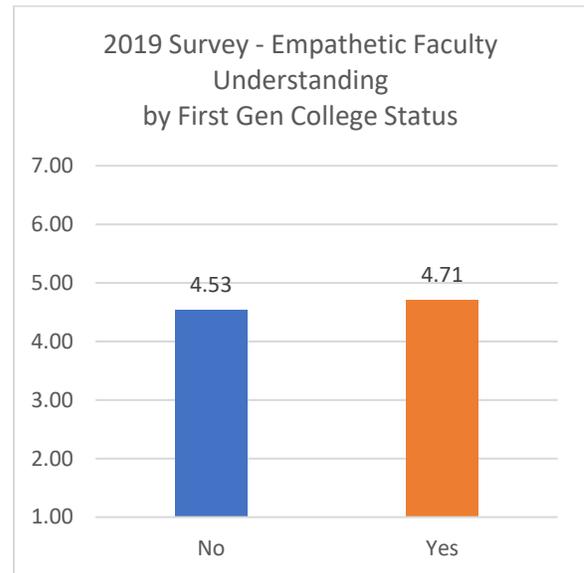
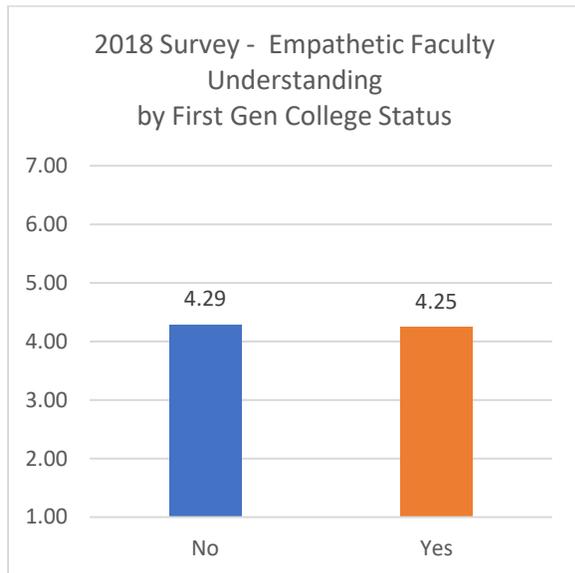


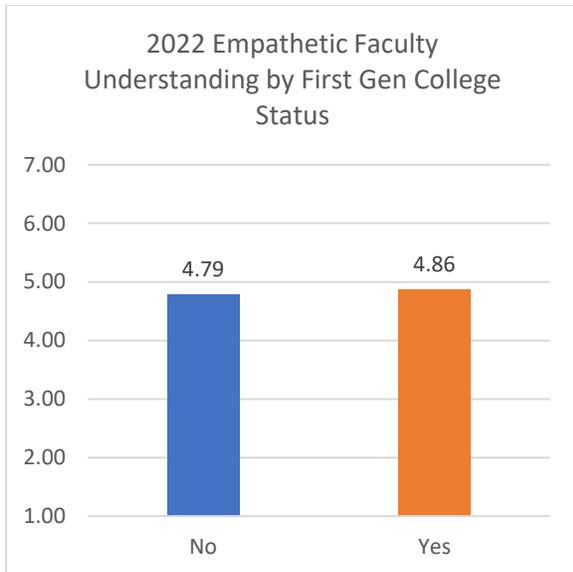
Sexual Minority Status



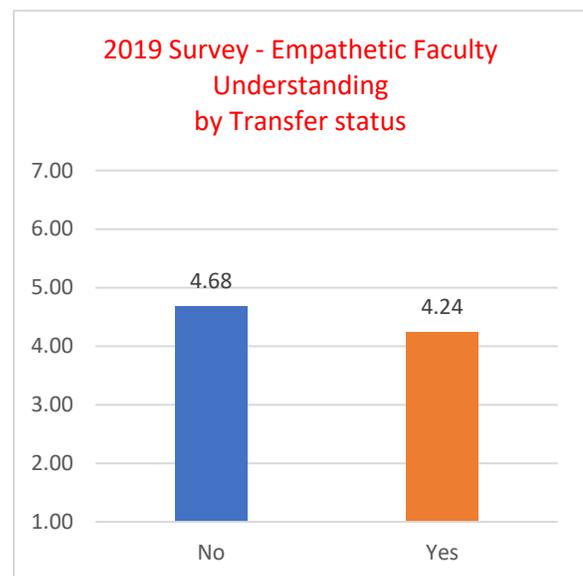
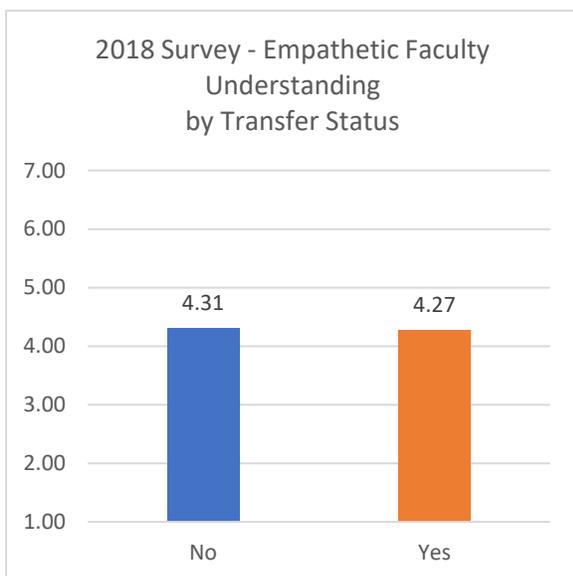


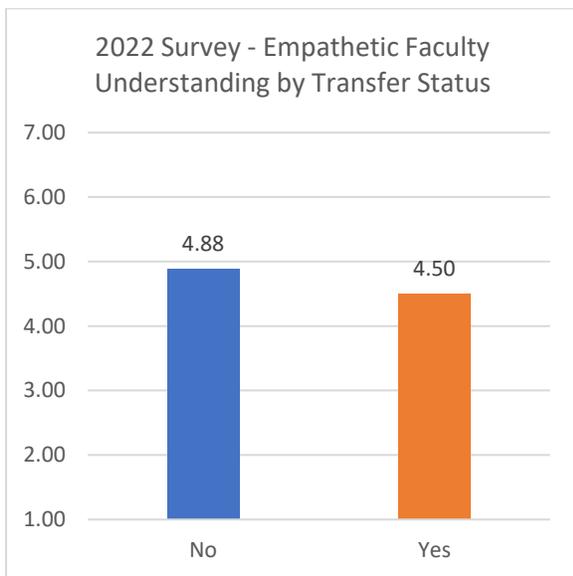
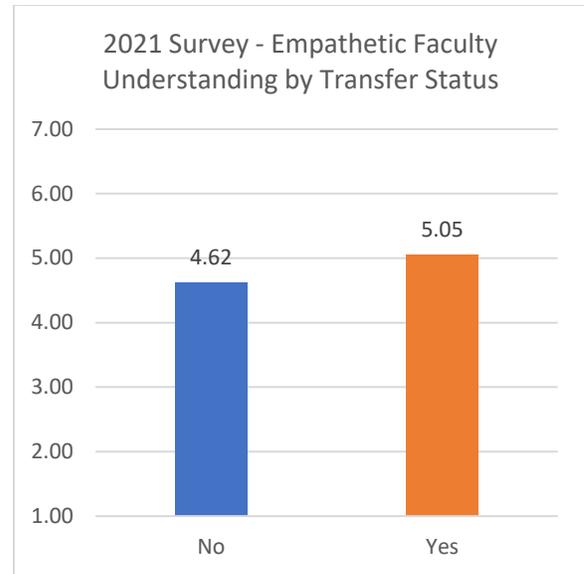
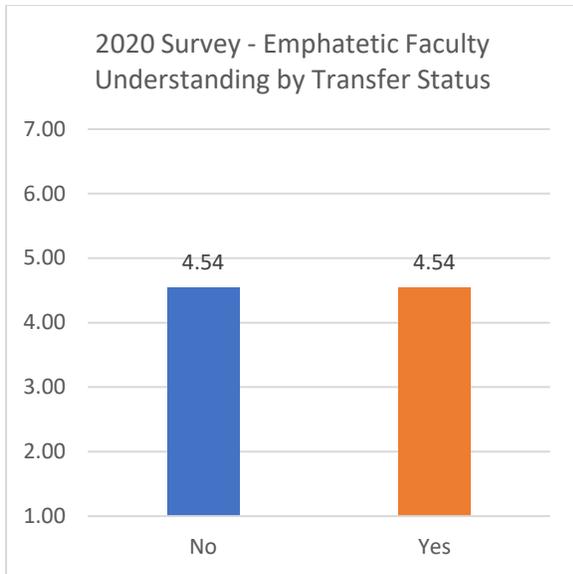
First-generation College Status



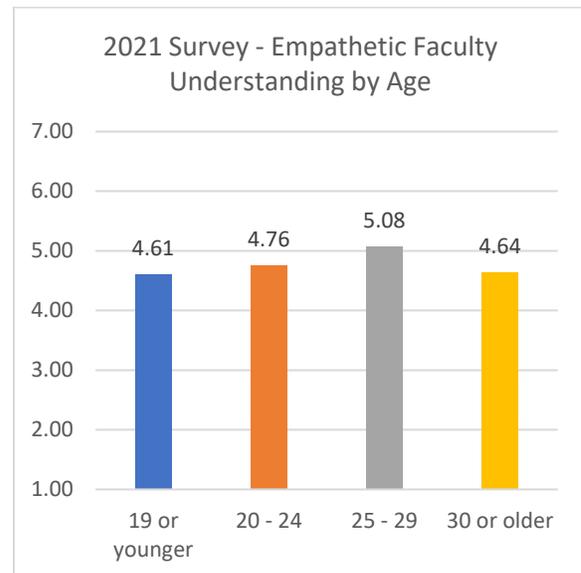
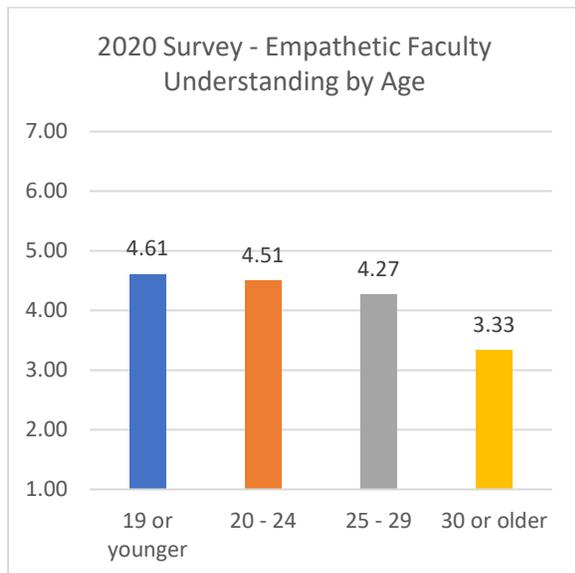
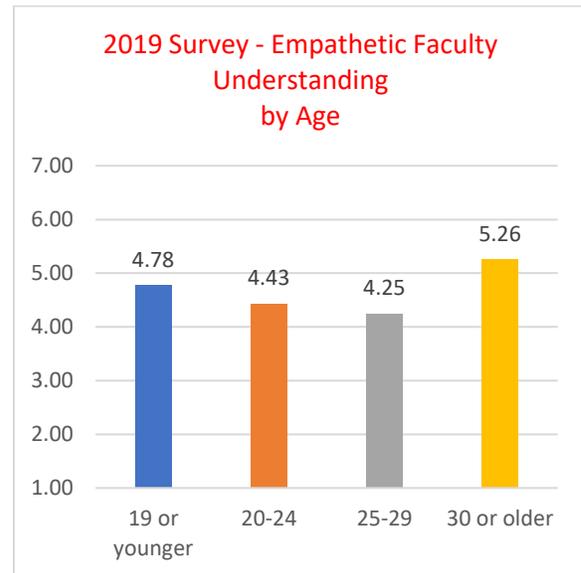
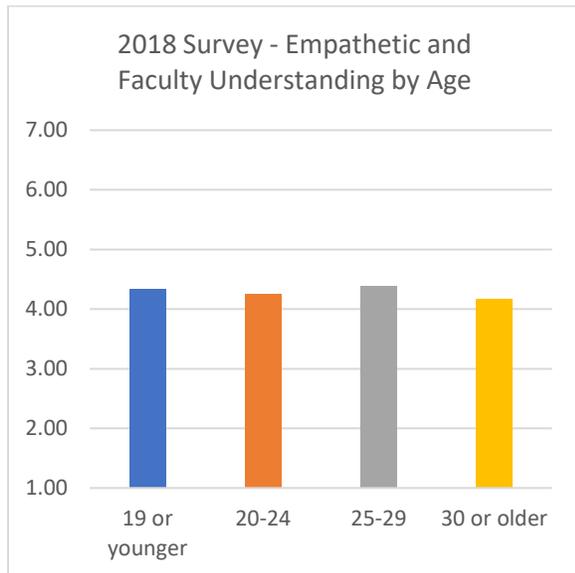


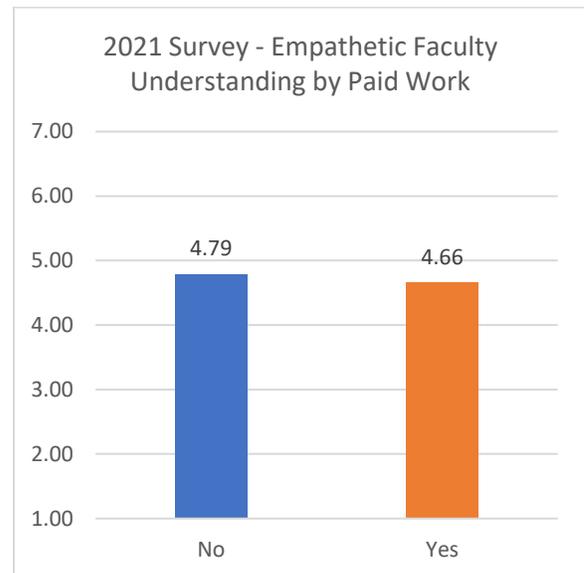
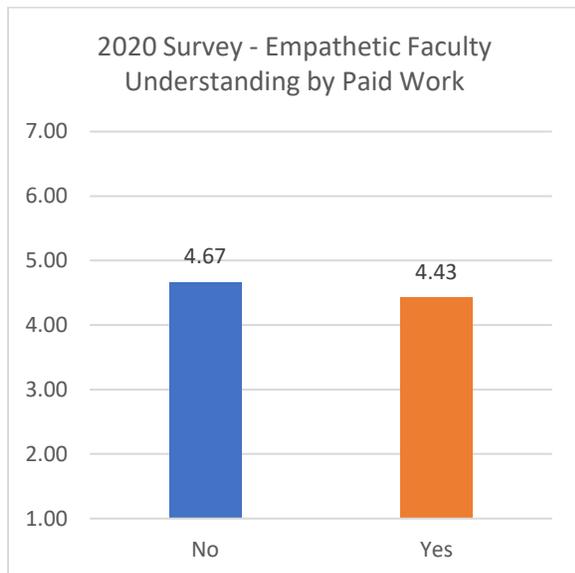
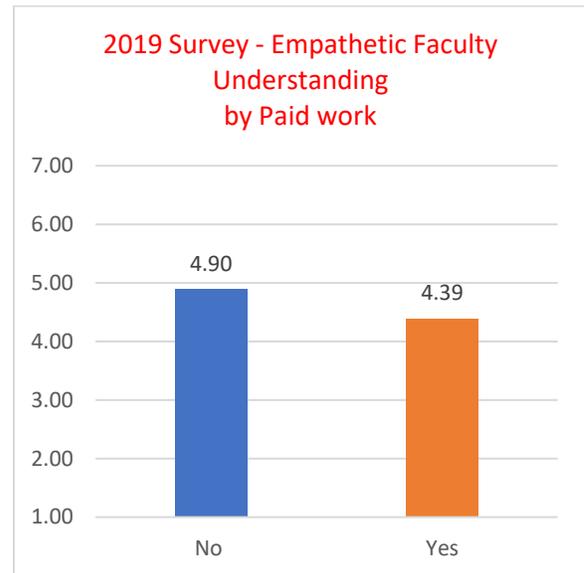
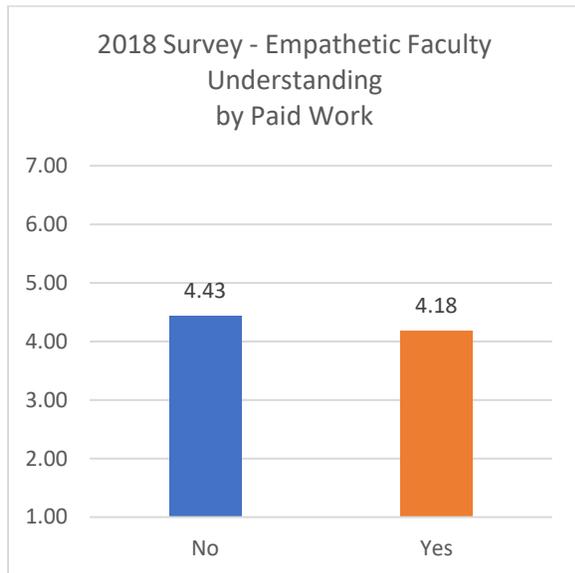
Transfer Status

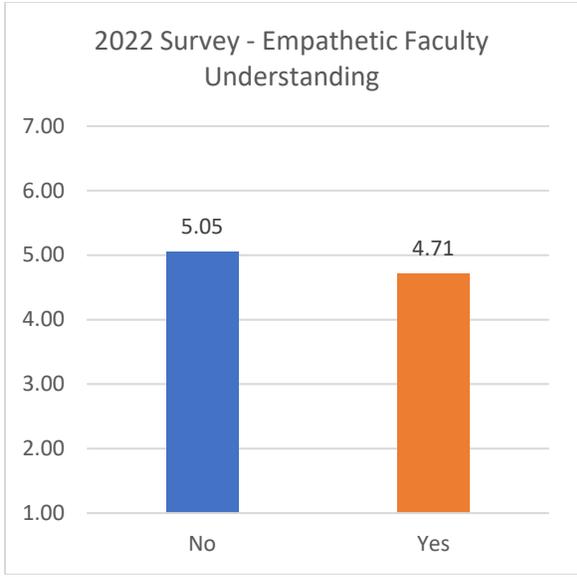




Age



Employment status



Self-Control (Impulsivity)

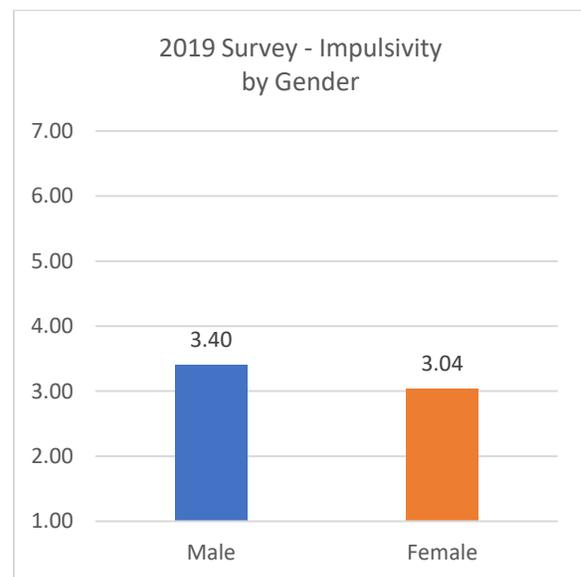
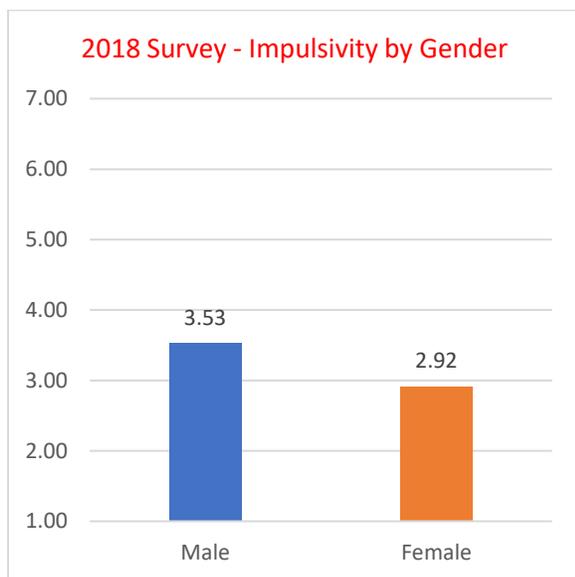
Self-control can be characterized by impulse-control (impulsivity)[60]. Students were presented with statements such as "Pleasure and fun sometimes keep me from getting work done." There are many reasons that self-control is theorized to contribute to success for college students. Self-control has been linked to better academic performance as measured by grades [27], better psychological adjustment and interpersonal skills [93], as well as better regulation of eating and alcohol consumption [44, 43, 2].

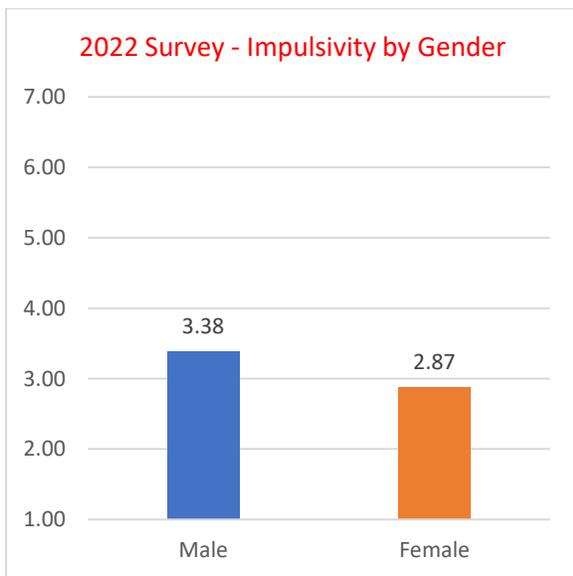
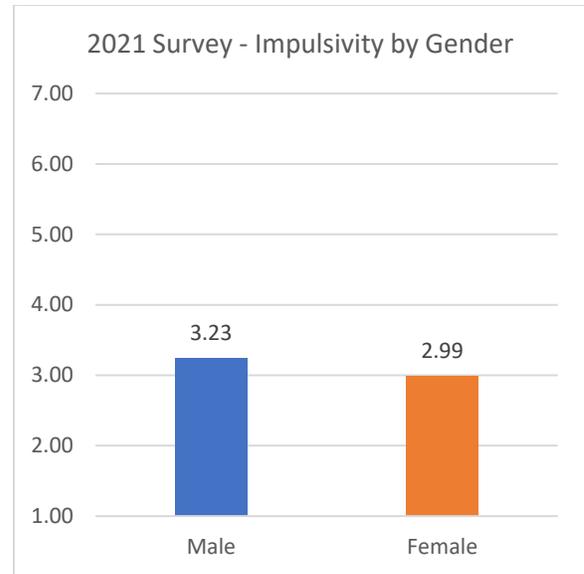
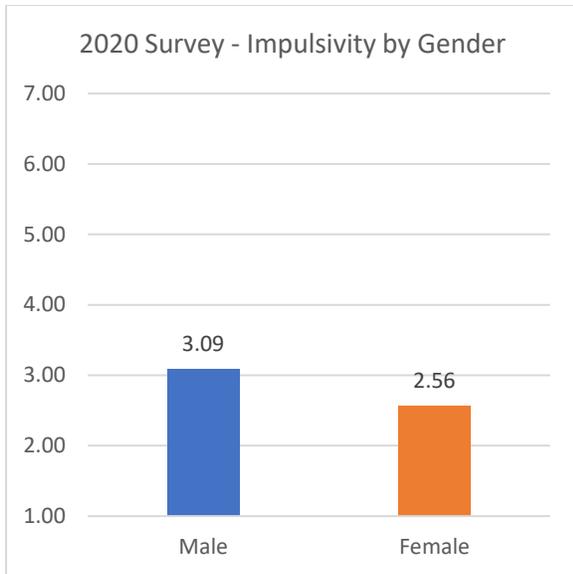
Number of items: 4

Interpretation of the scale: Higher self-control scores indicate that students have higher levels of self-discipline and impulse-control

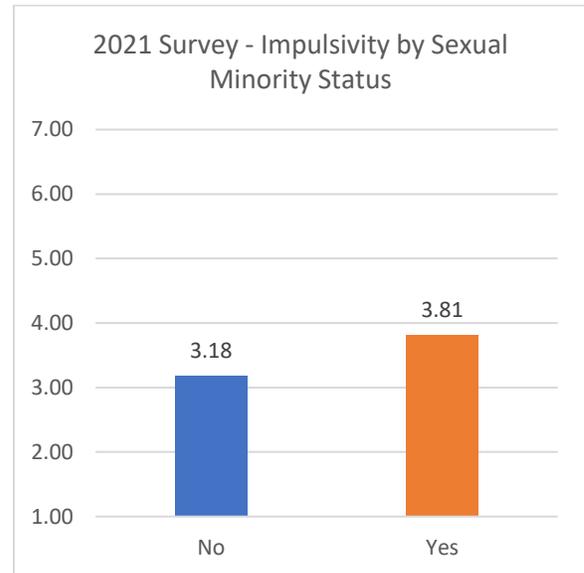
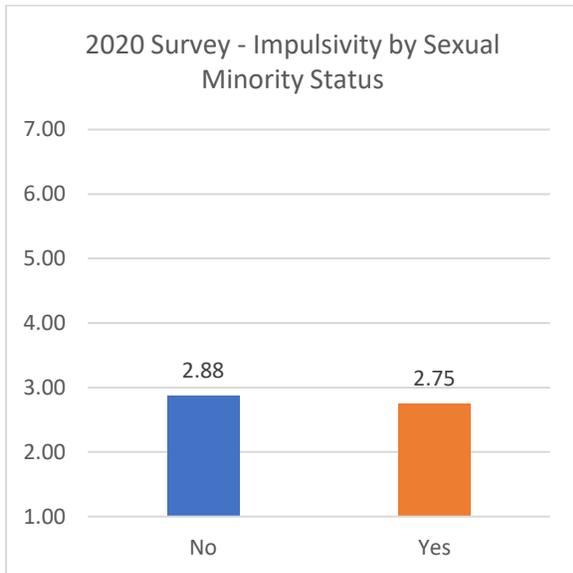
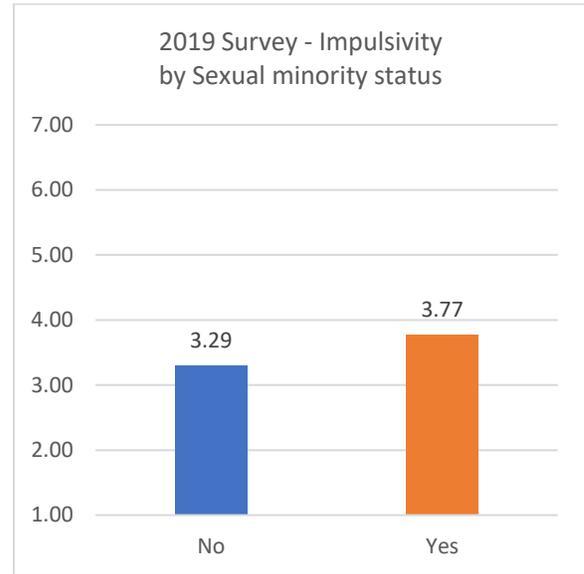
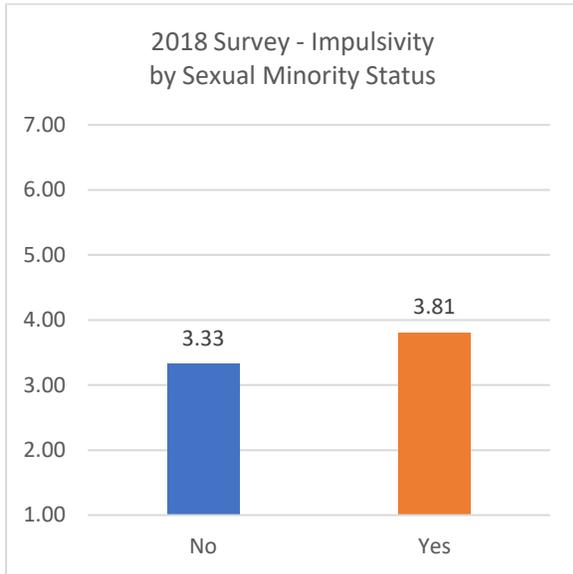
Malleability: Employing self-control behaviors seems to weaken one's ability to continue to employ self-control behaviors [70]. That is, self-control is believed to be a depletable resource. Self-control is also considered part of personality [93], which generally does not fluctuate over the long term. There is little available work that describes how to positively influence self-control within an educational setting.

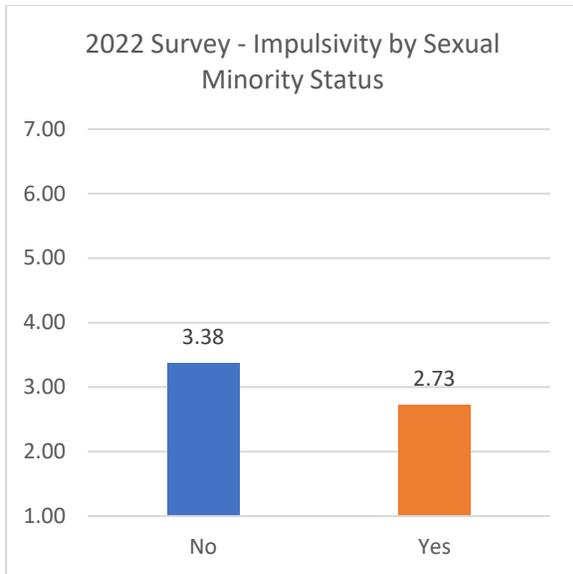
Gender



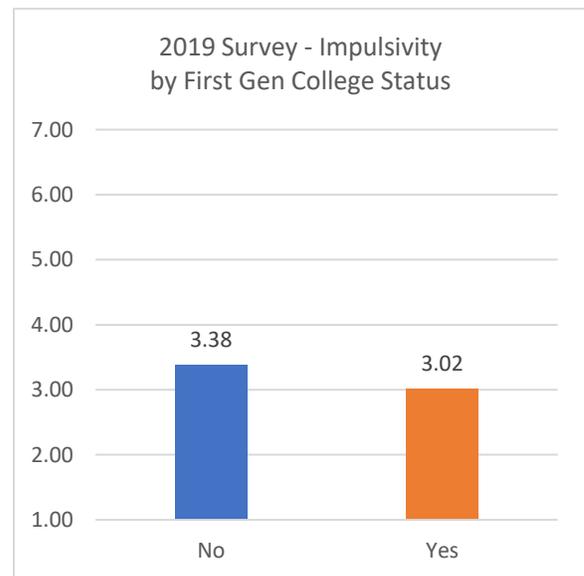
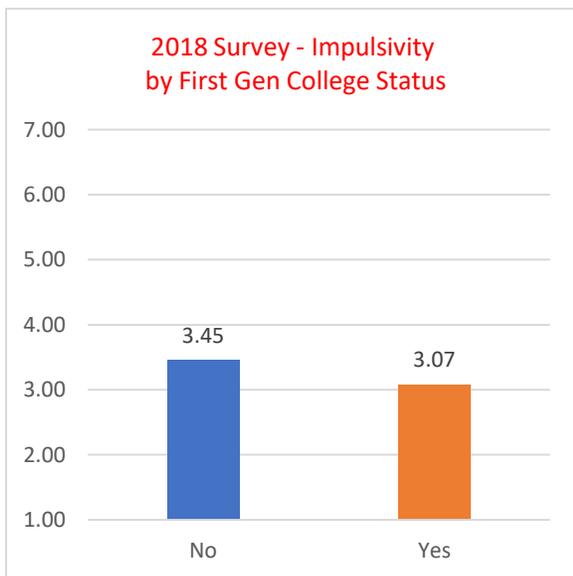


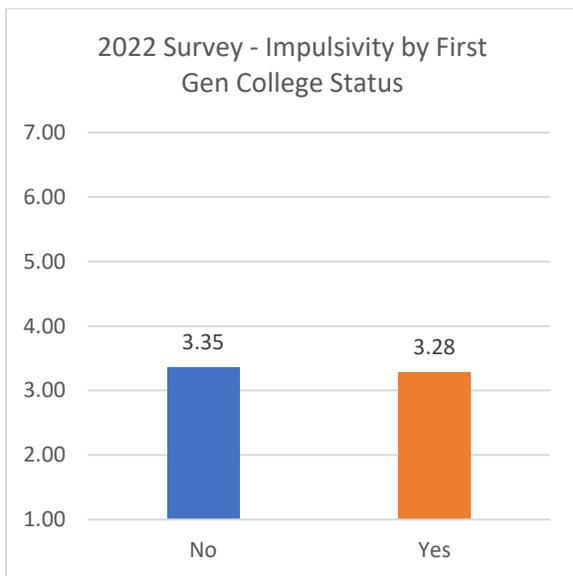
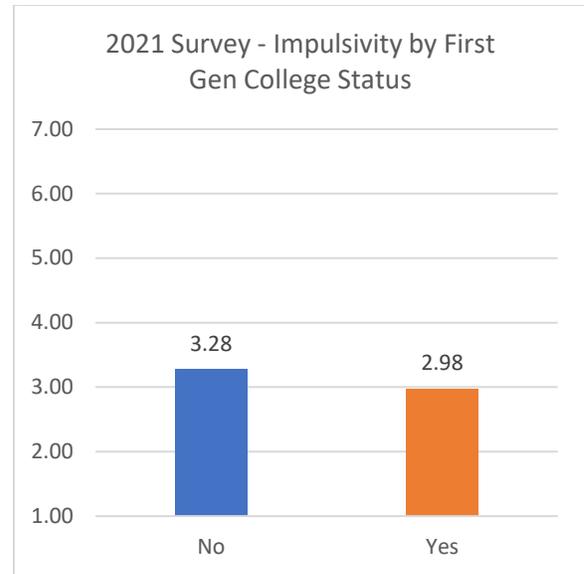
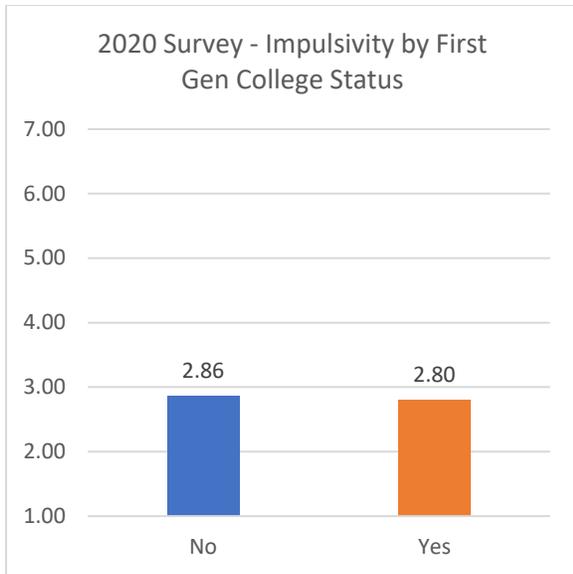
Sexual Minority Status



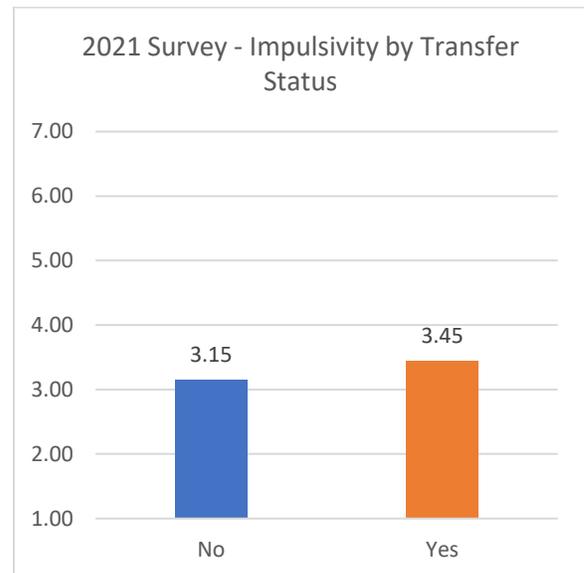
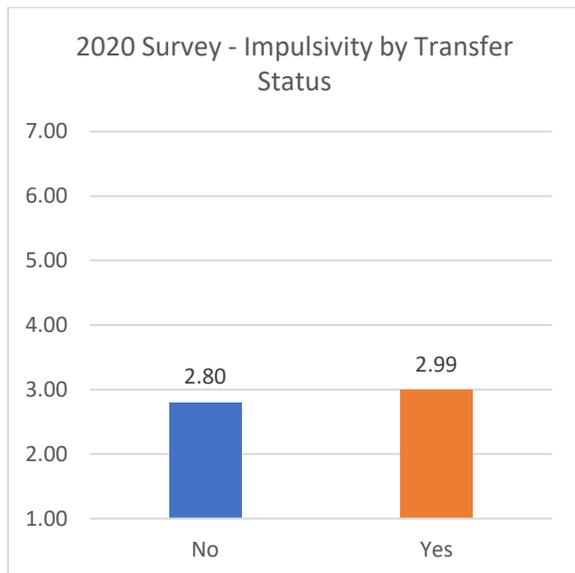
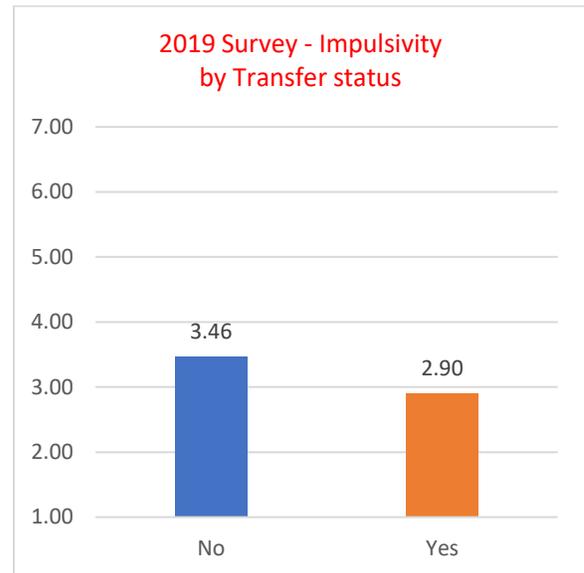
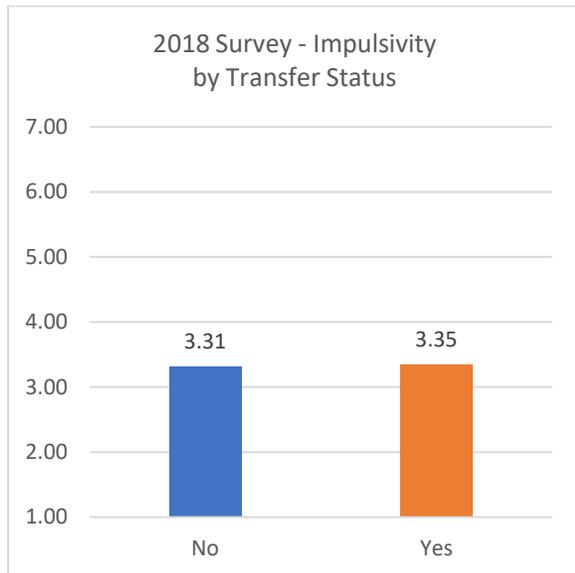


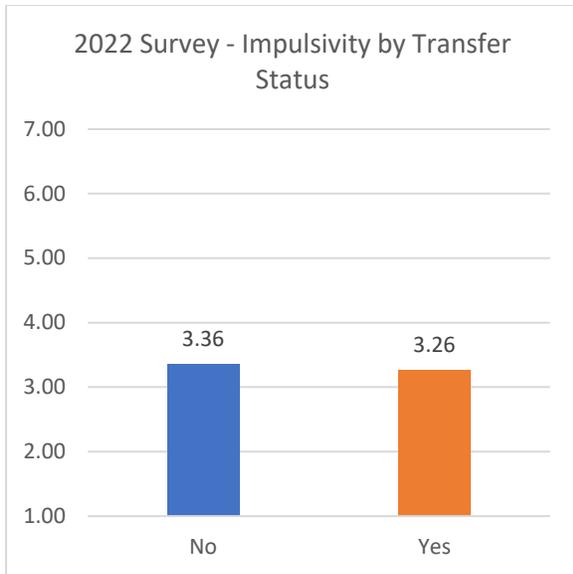
First-generation College Status



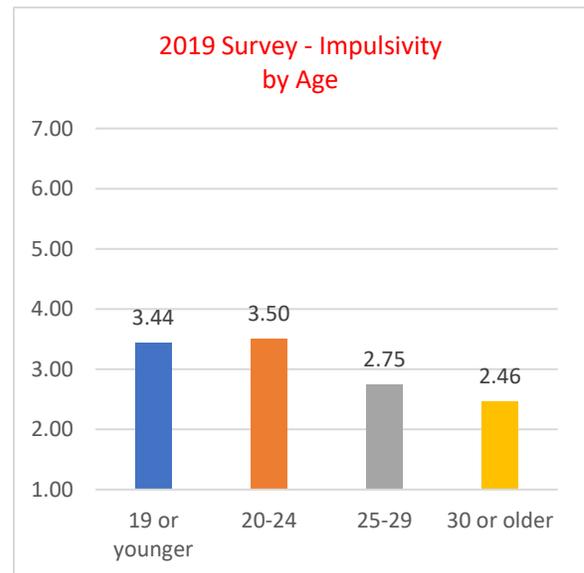
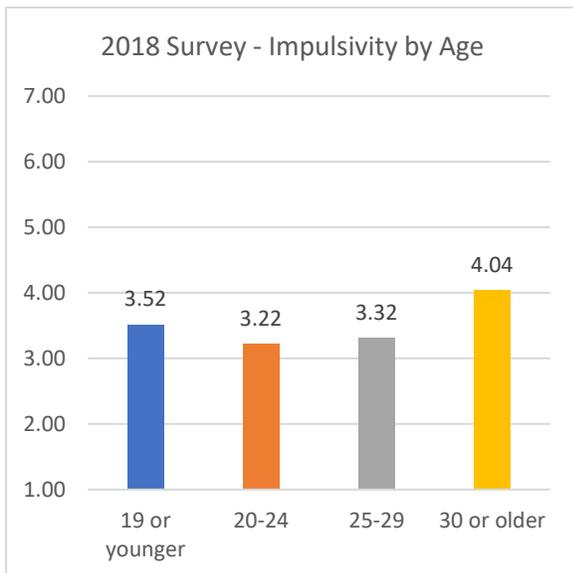


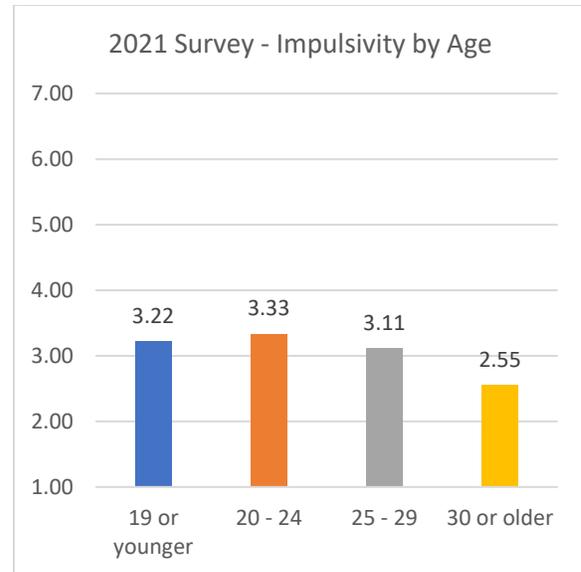
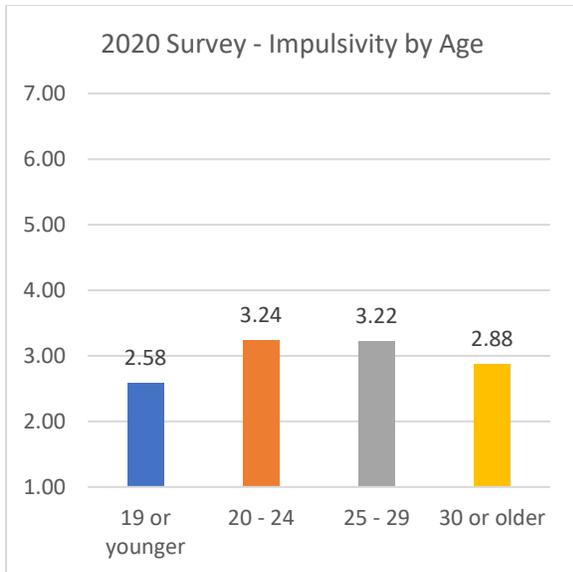
Transfer Status



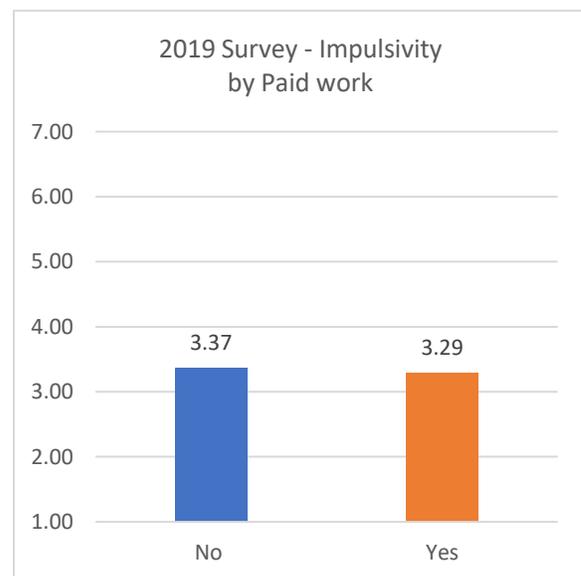
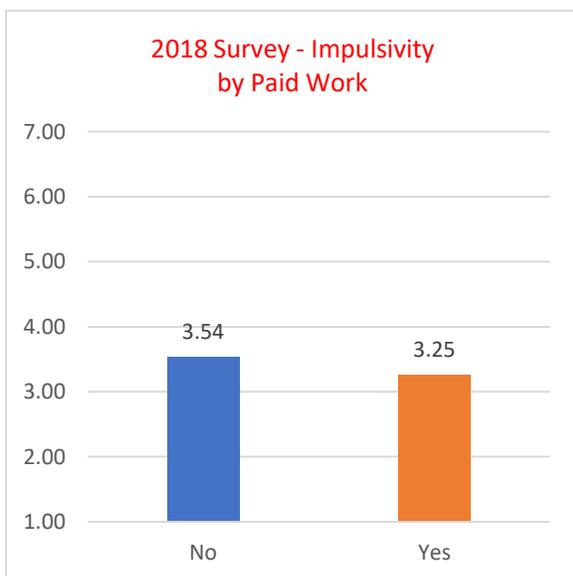


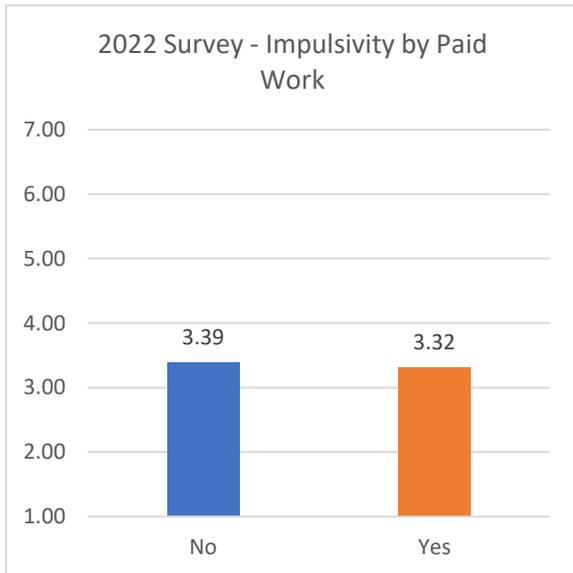
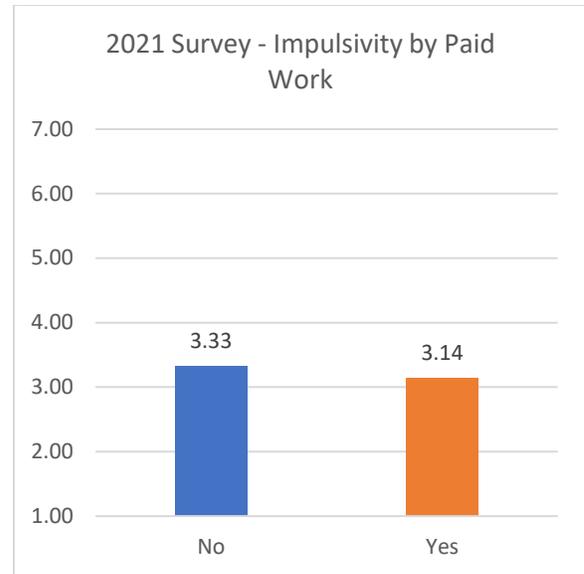
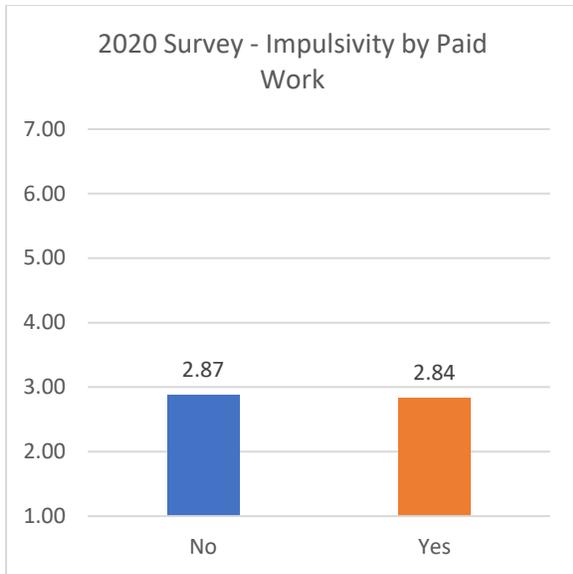
Age





Employment status





Student Life Stress

We measured student life stress through 5 different dimensions, including stress due to changes (disruption of goals, many changes occurring simultaneously), frustrations as a result of not achieving goals, conflicts (with positive and/or negative options), reactions to stress (sweating, fear, irritability, etc.), and stress support (peer, family, exercise, etc.). Stress can greatly impact student performance, both positively and negatively [33].

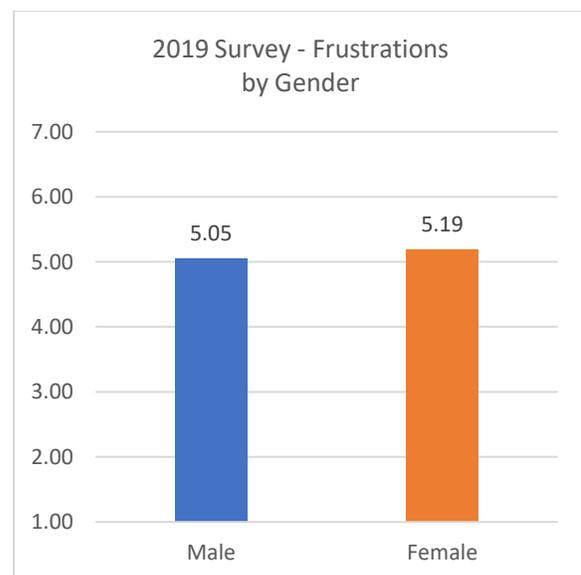
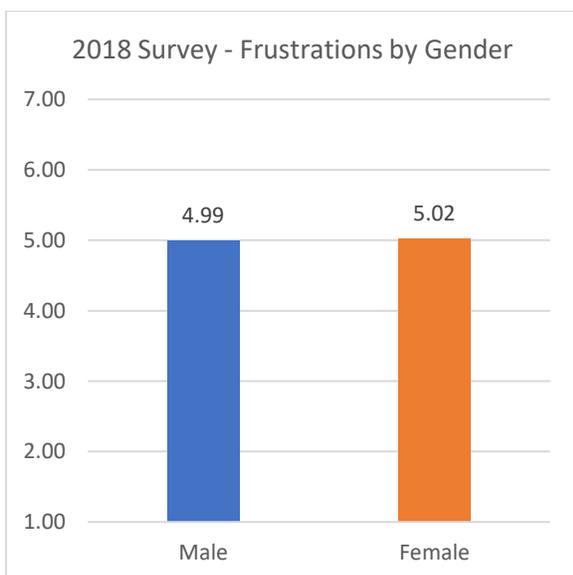
Number of items: 14

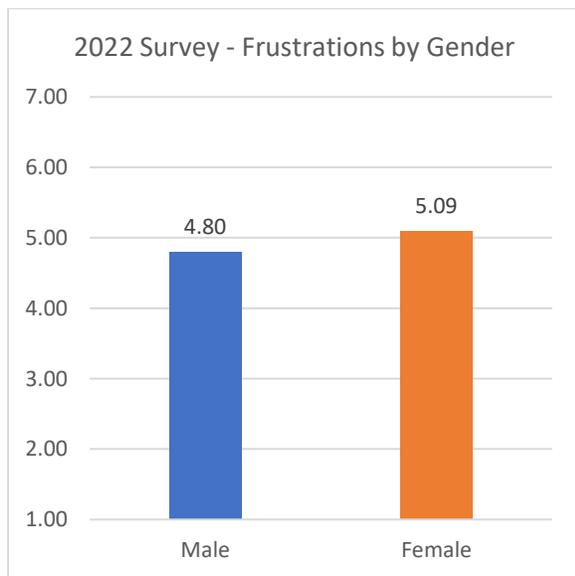
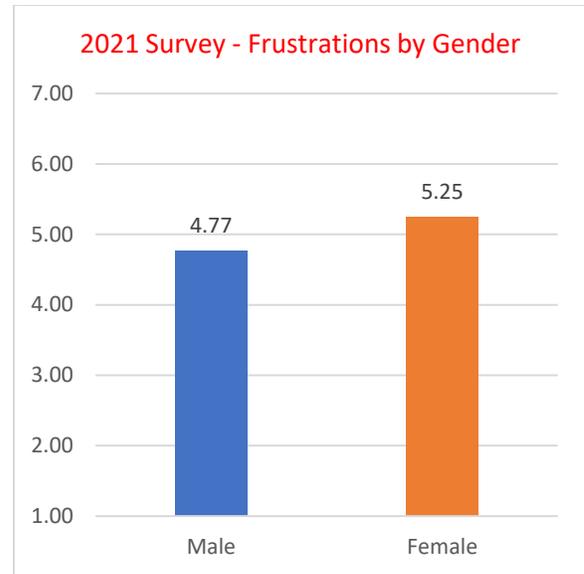
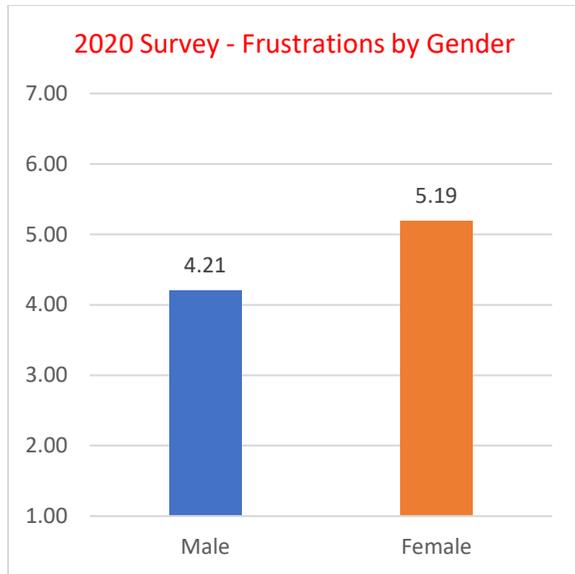
Interpretation of the scale: Higher scores indicate that students experience more stress in various dimensions of life.

Malleability: In general, time management skills can help moderate stress [67]. Additionally, women and men cope differently in response to stress [67, 8], which suggests different interventions for stress may be necessary to address stress throughout the student population. An example intervention technique to help combat stress includes improving overall mindfulness. Mindfulness-based stress reduction (see the [Mindfulness](#) section) has been shown to effectively reduce stress in otherwise healthy individuals [11].

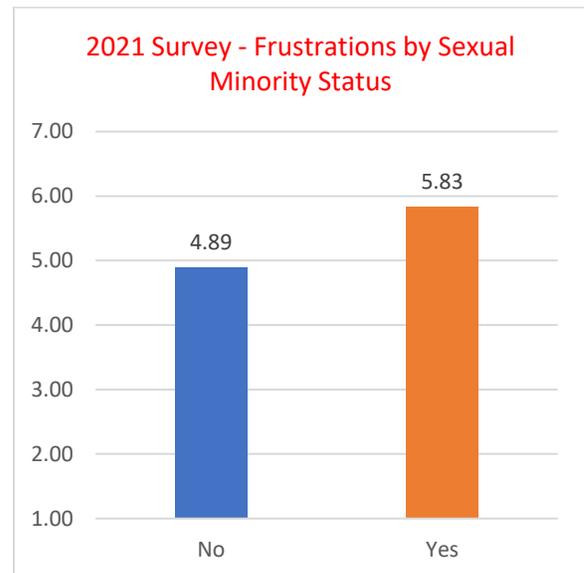
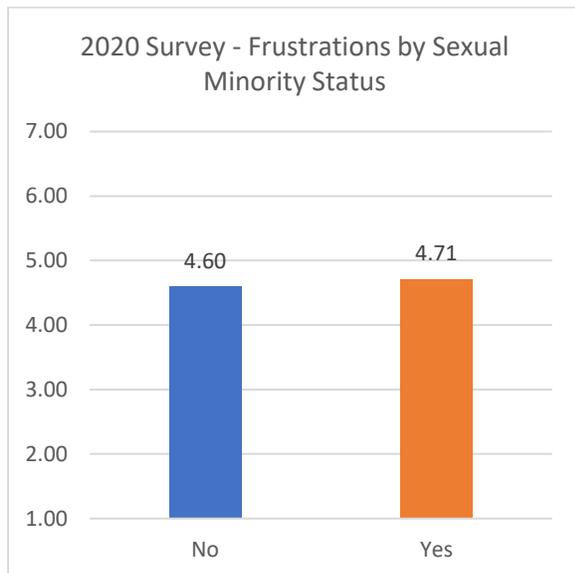
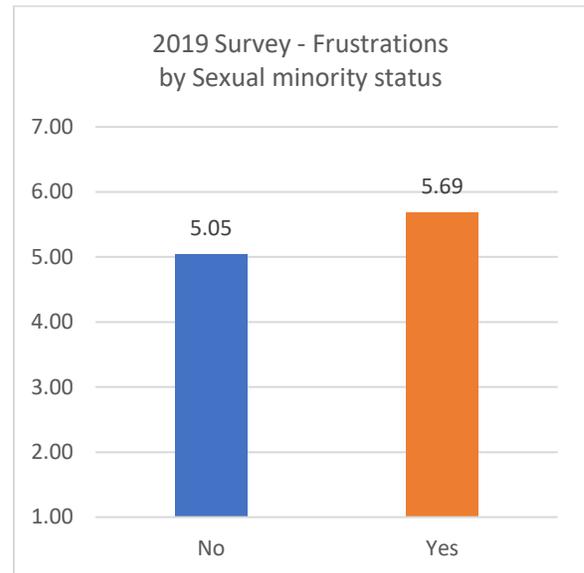
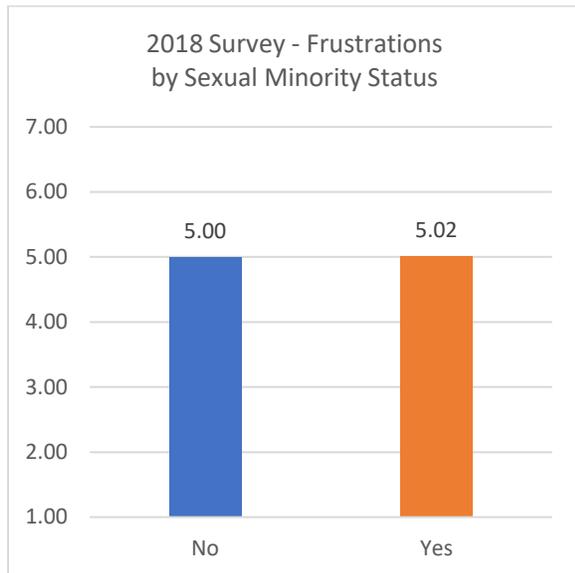
1) Frustrations

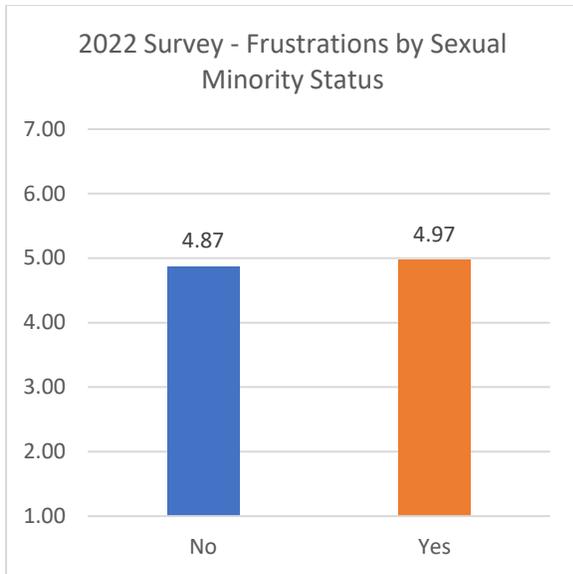
Gender



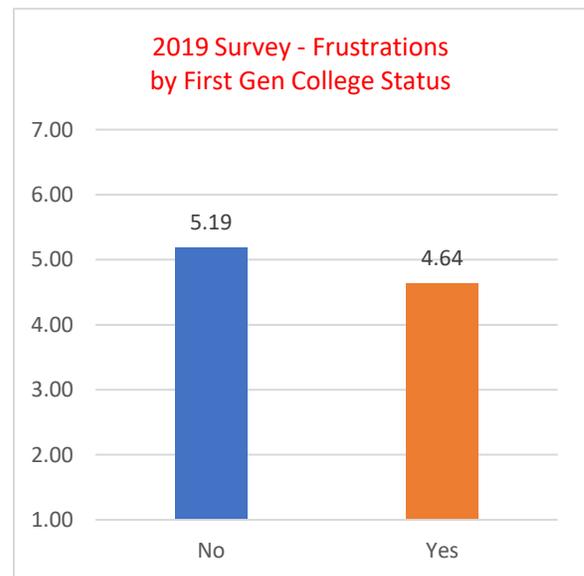
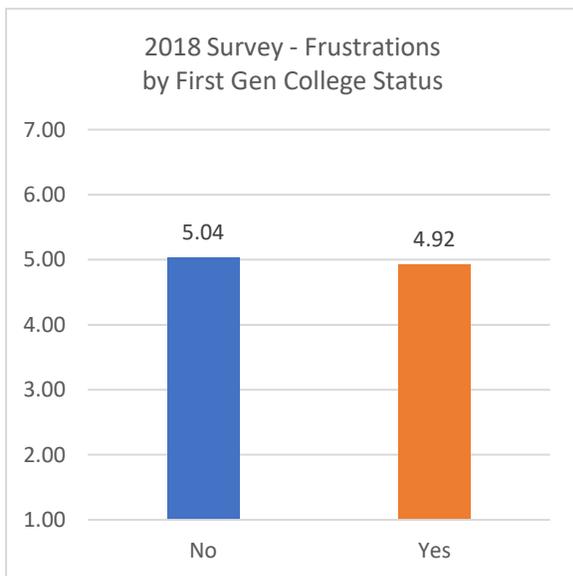


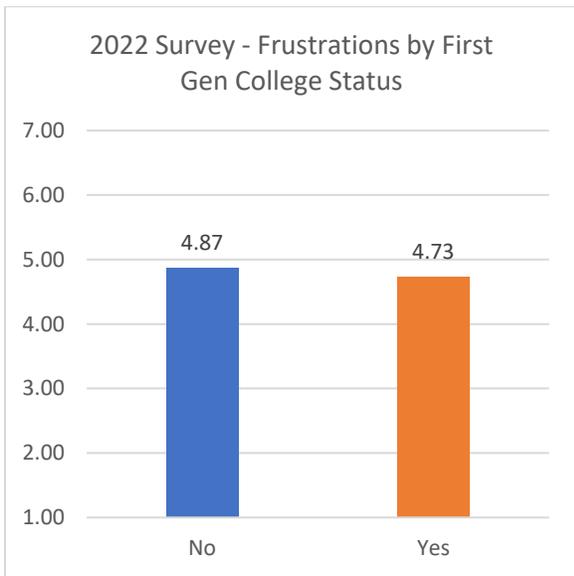
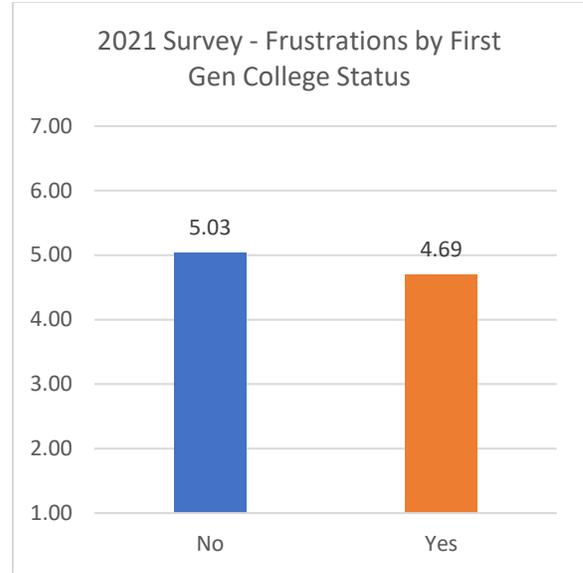
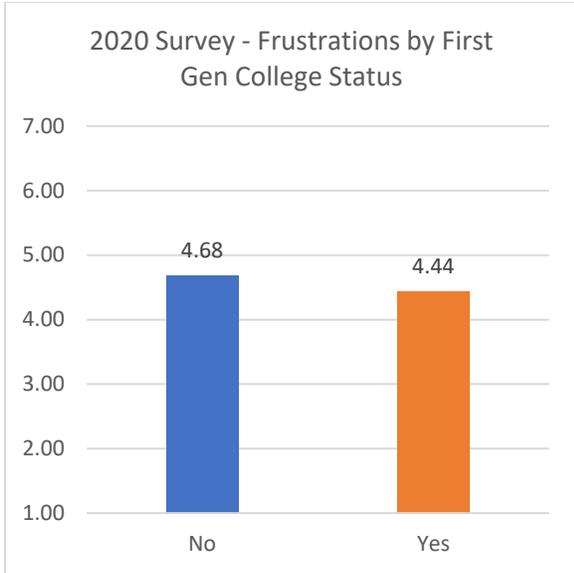
Sexual Minority Status



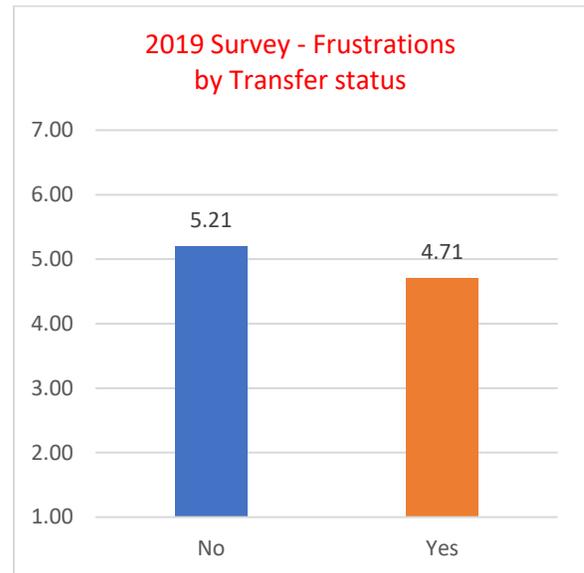
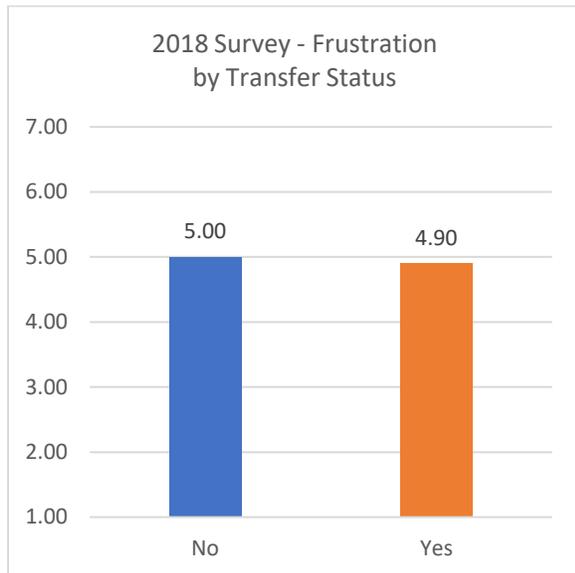


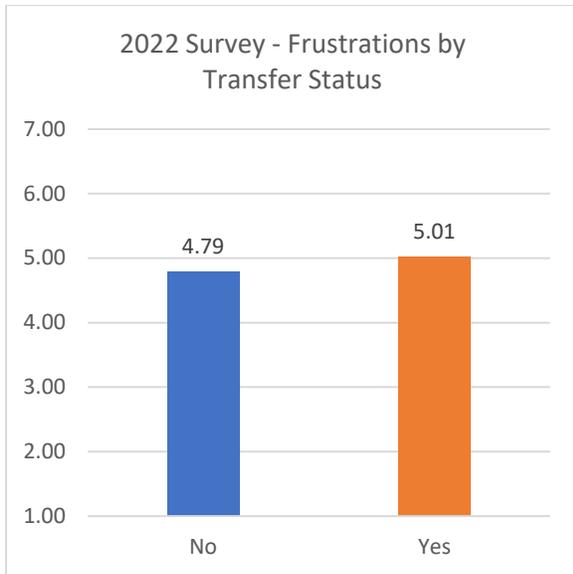
First-generation College Status



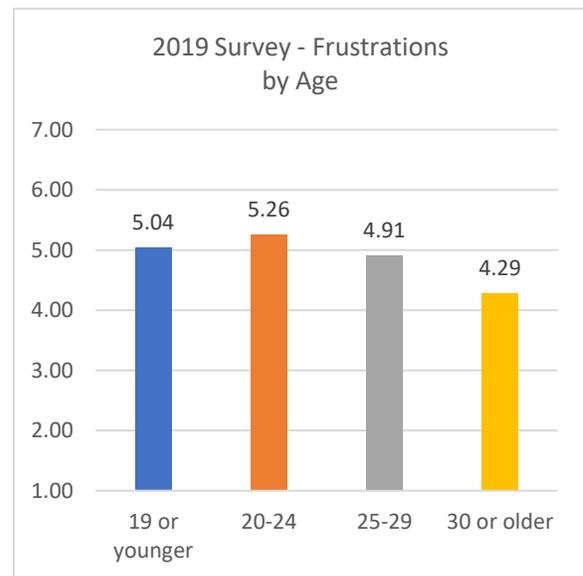
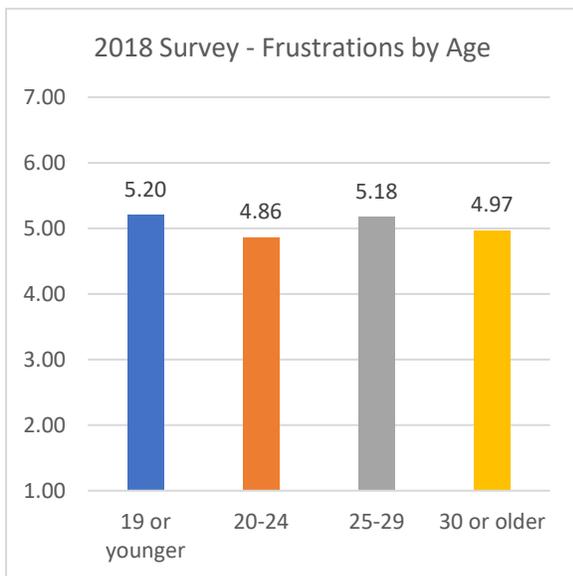


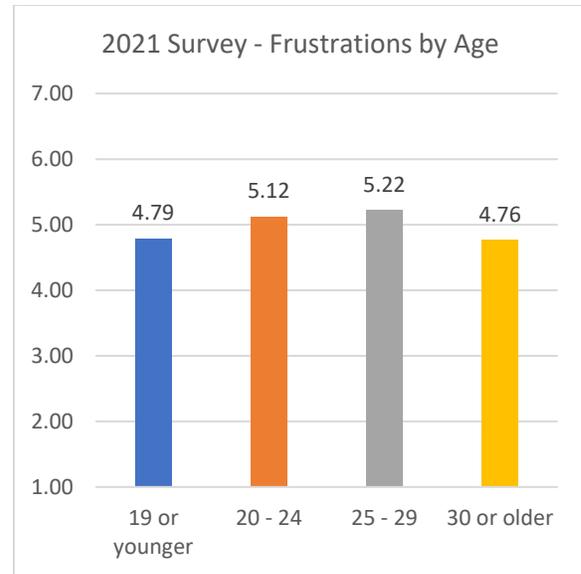
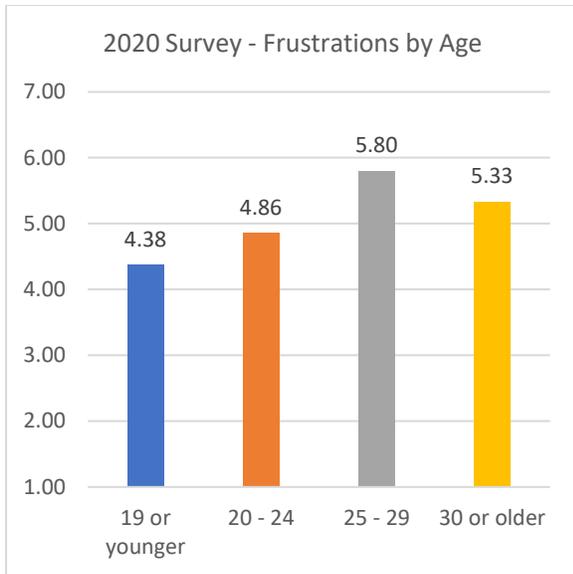
Transfer Status



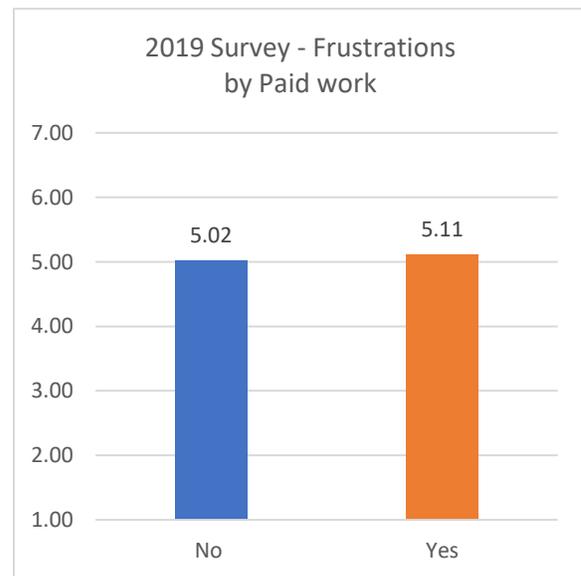
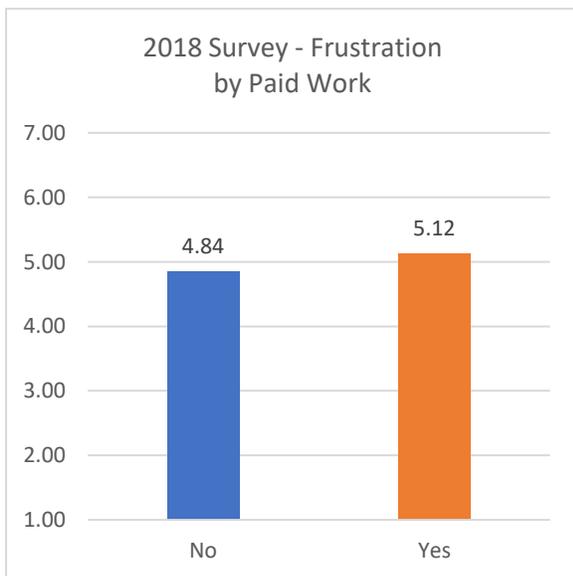


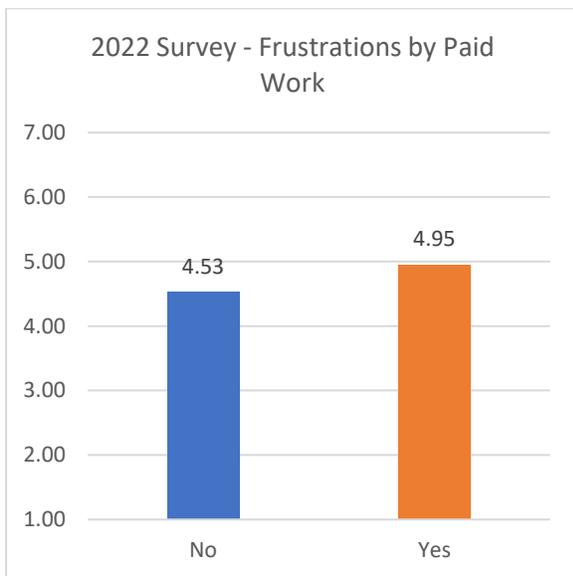
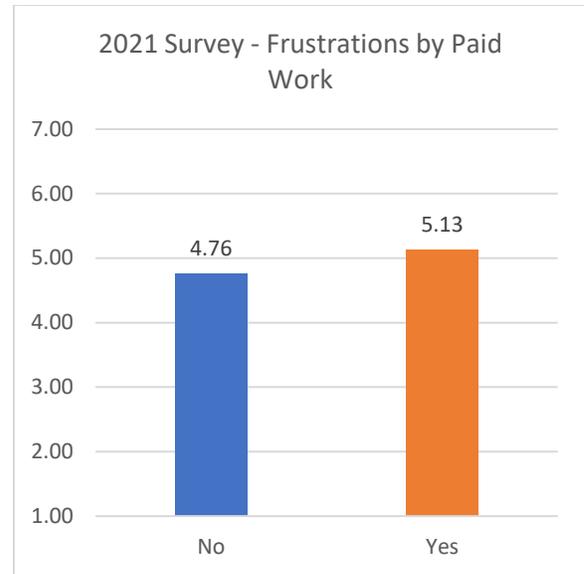
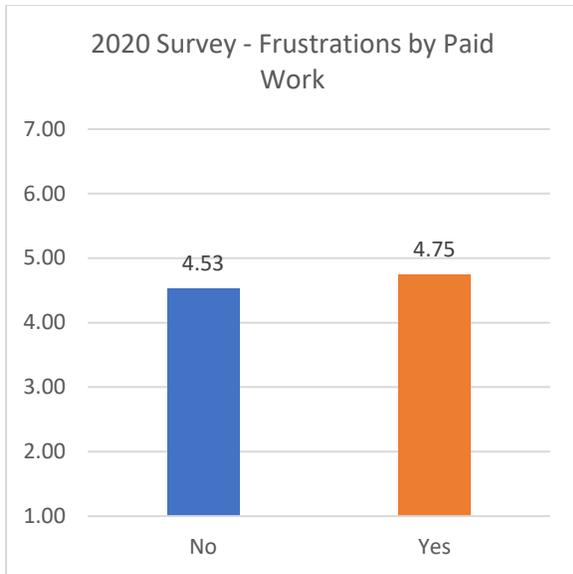
Age





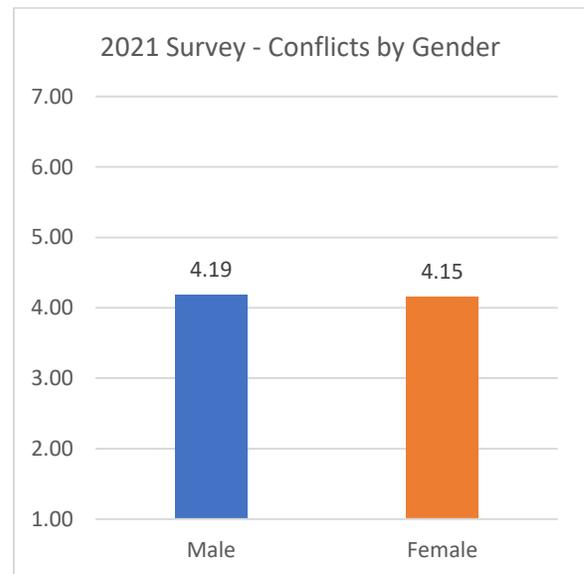
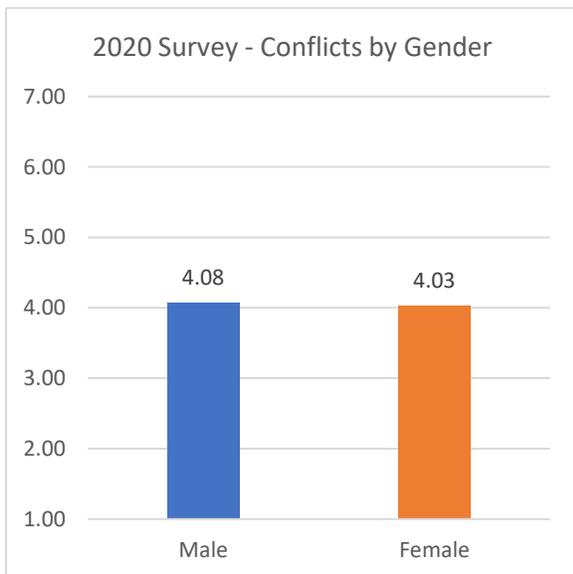
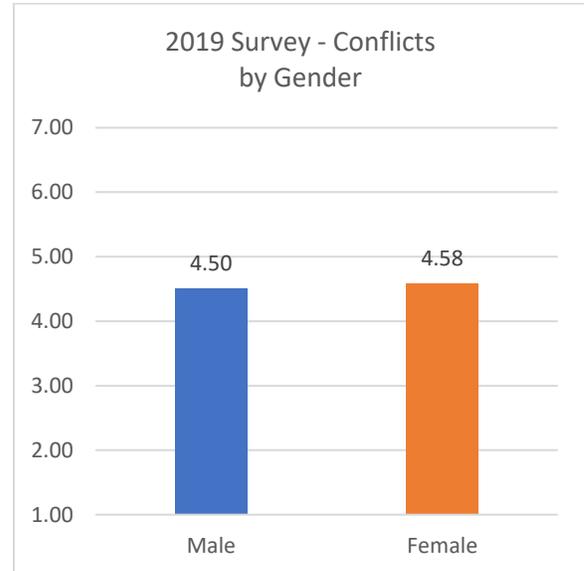
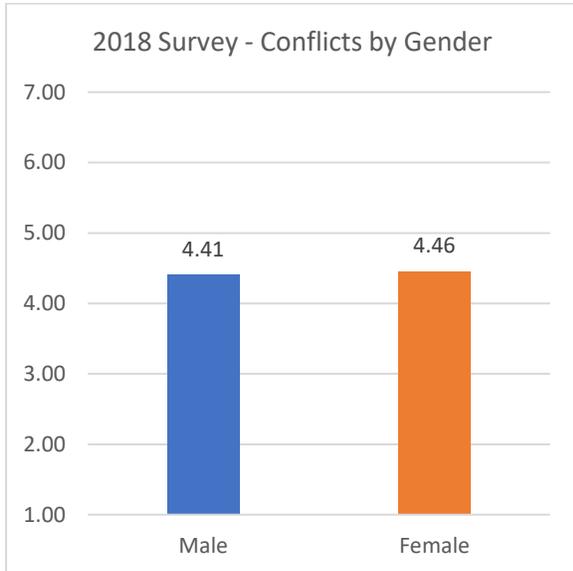
Employment status

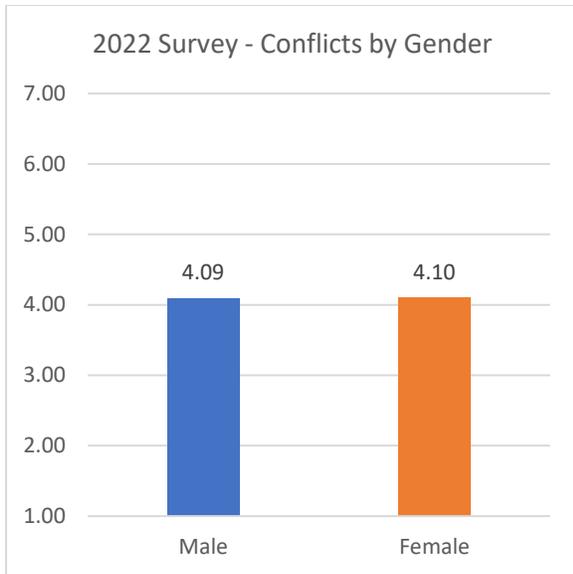




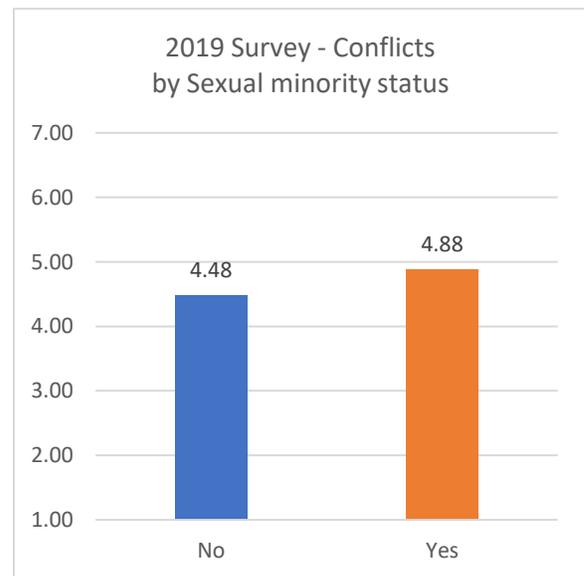
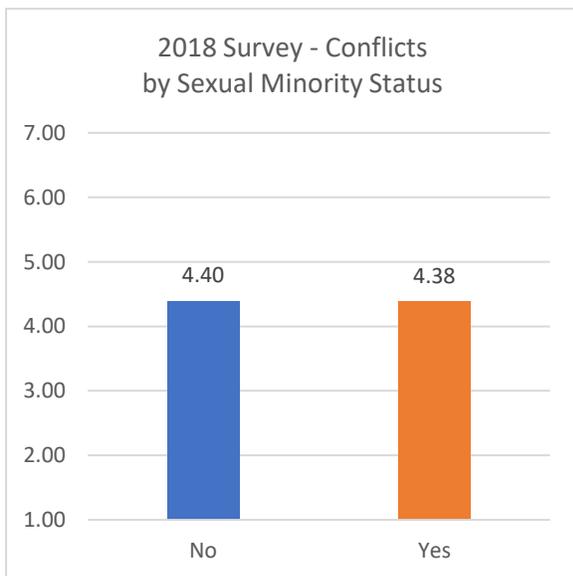
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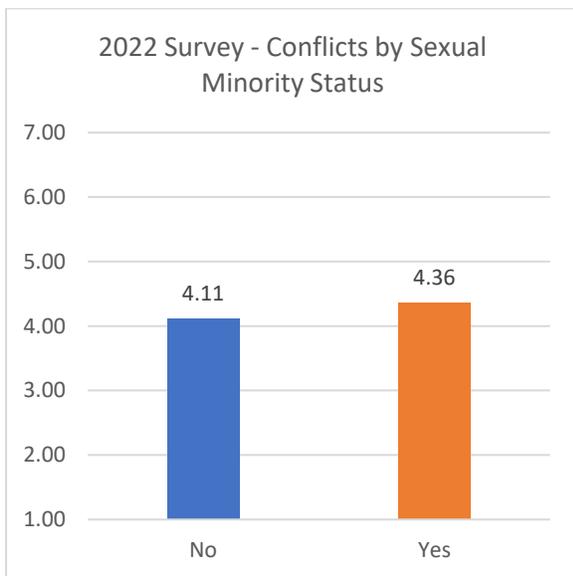
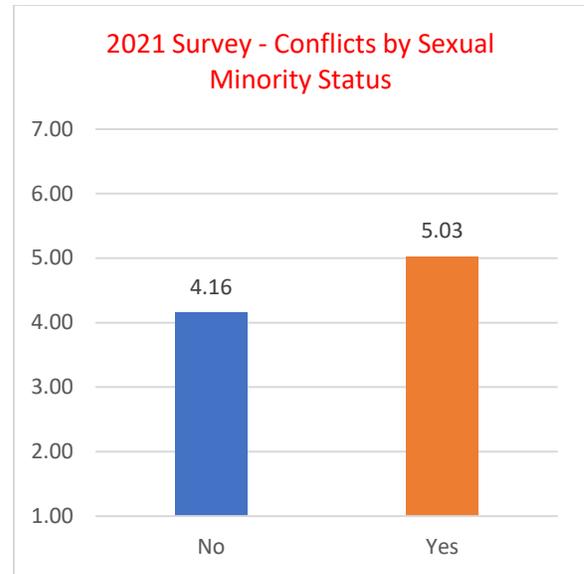
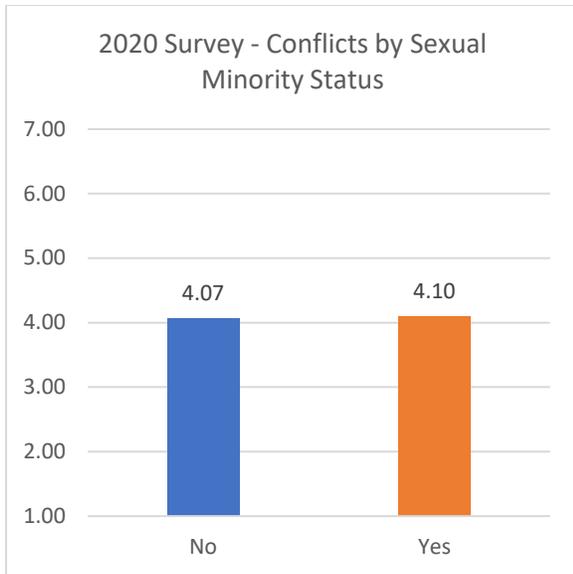
Gender



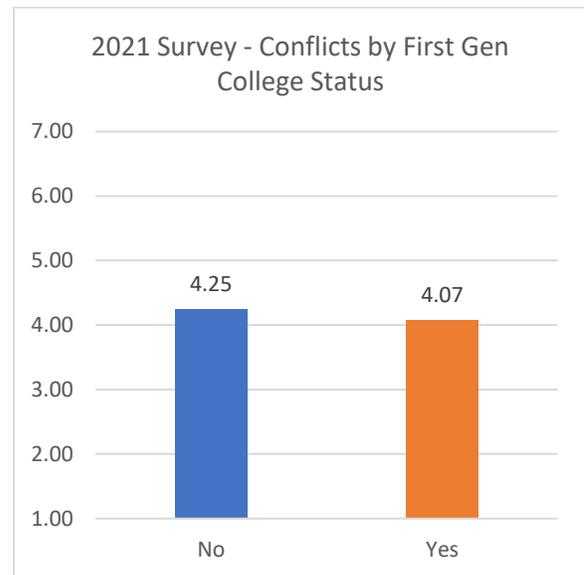
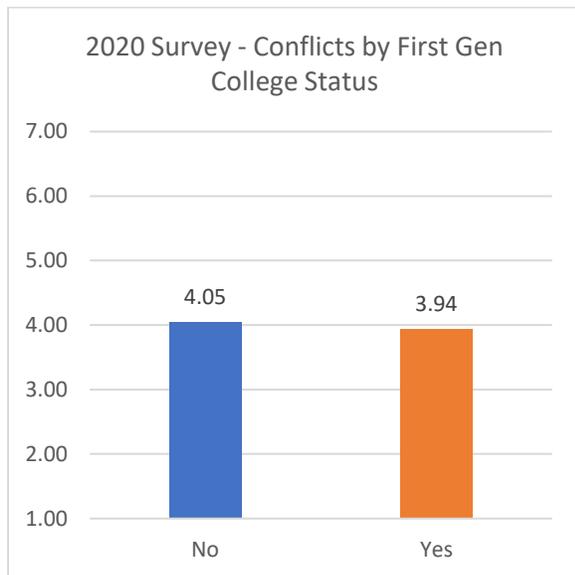
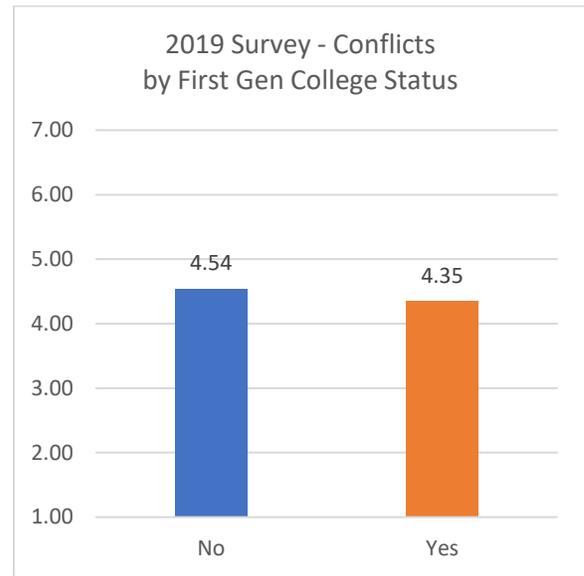
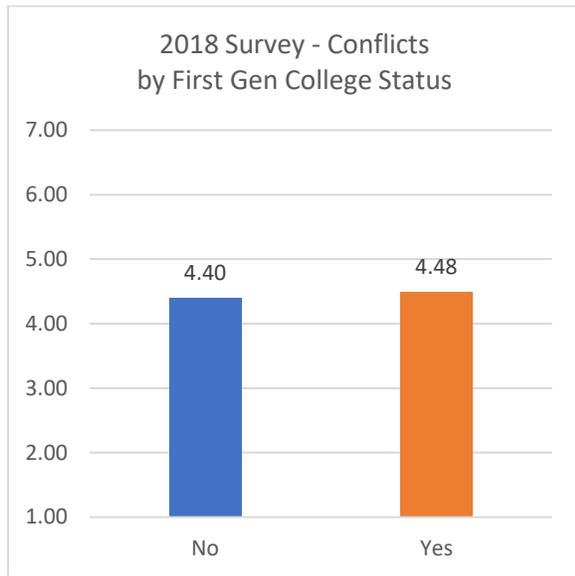


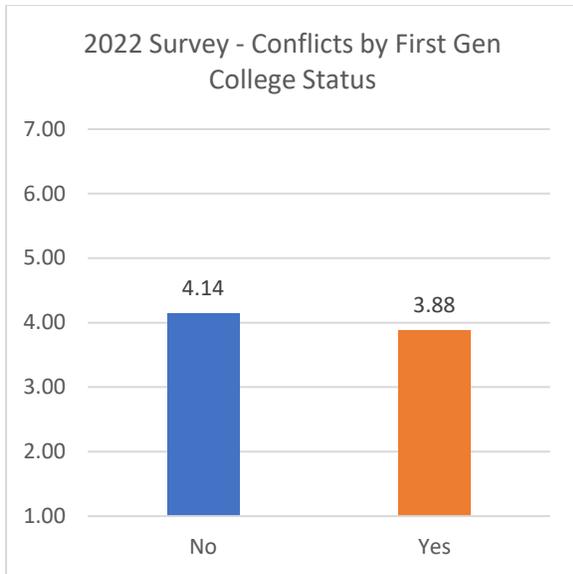
Sexual Minority Status



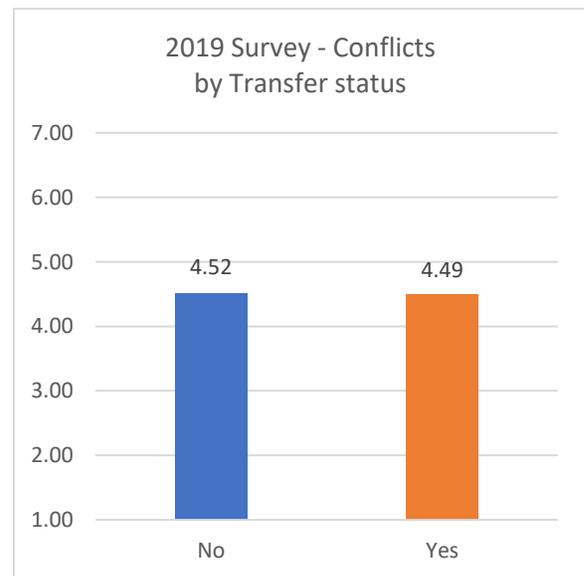
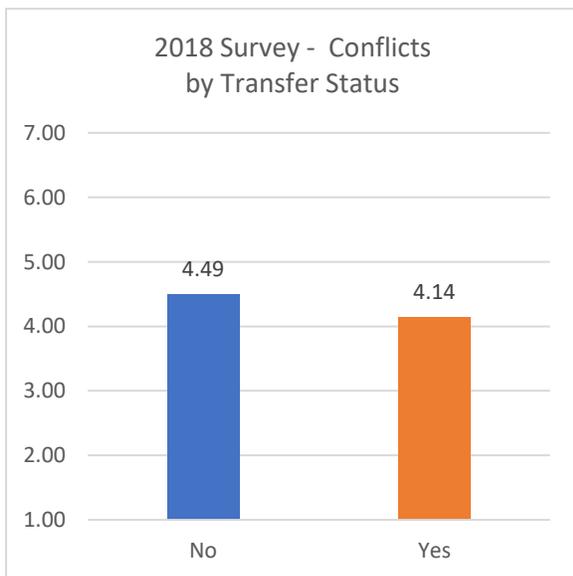


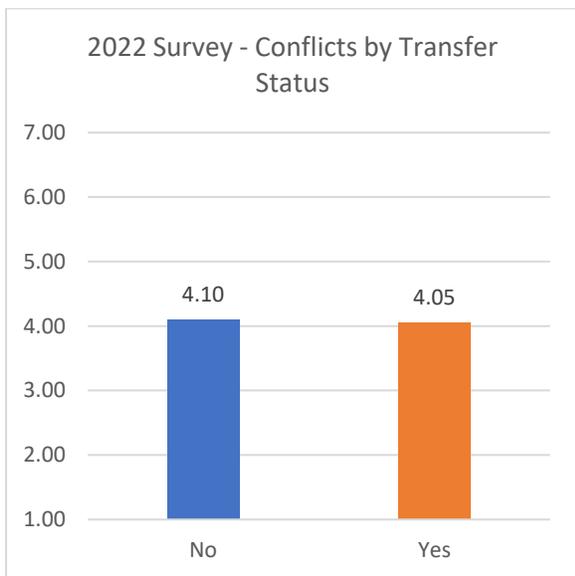
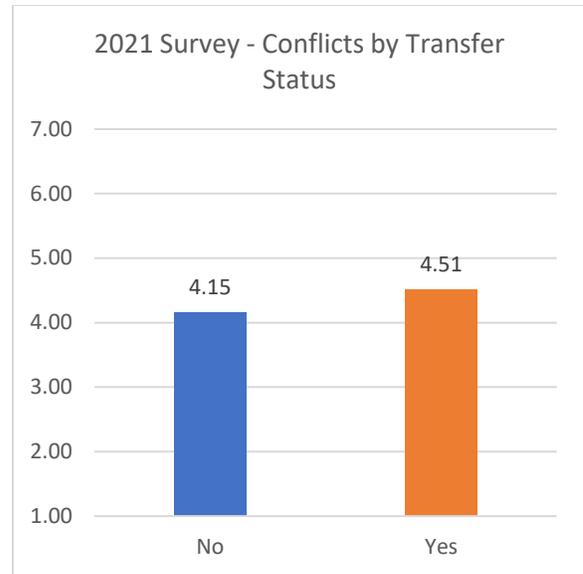
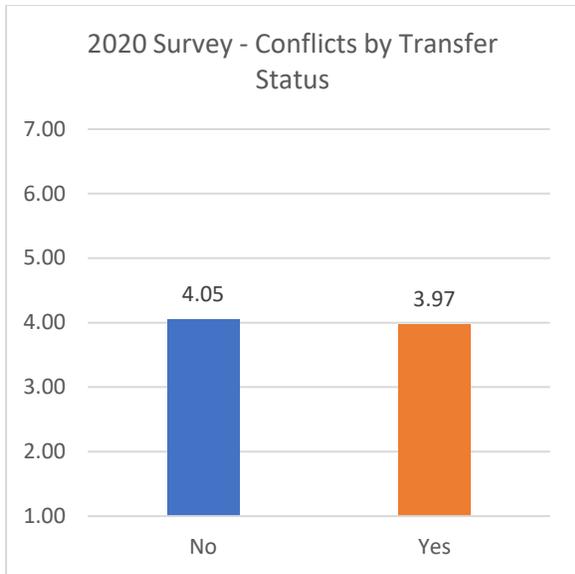
First-generation College Status



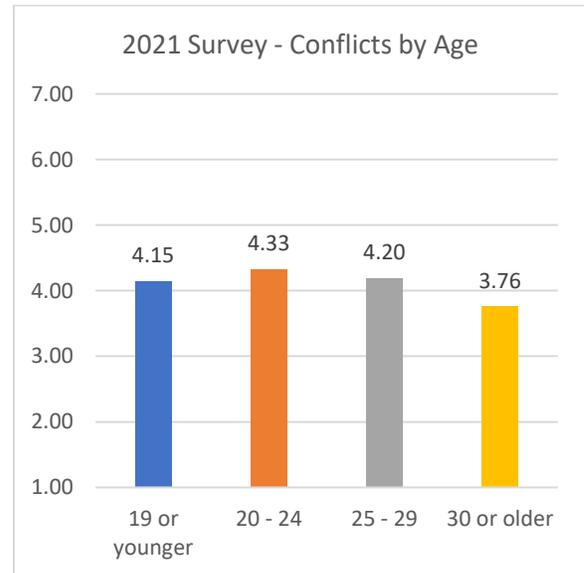
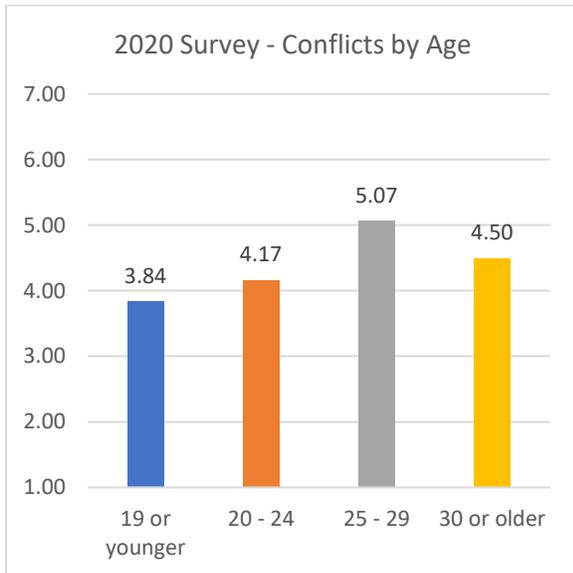
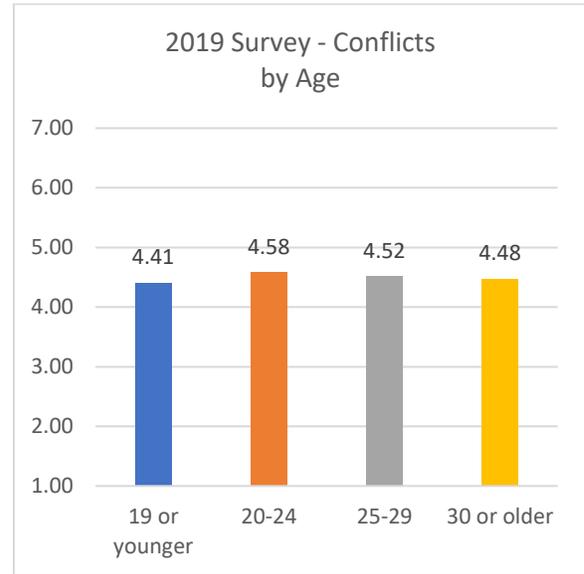
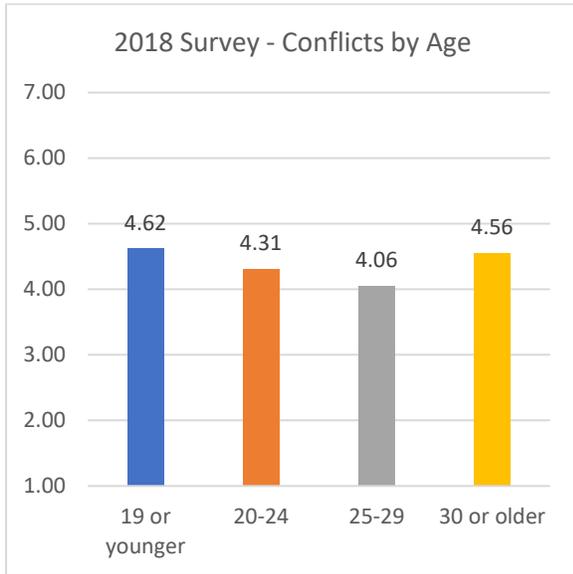


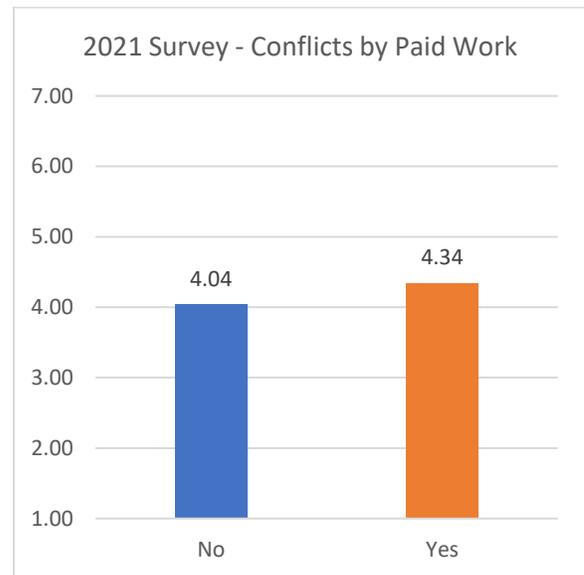
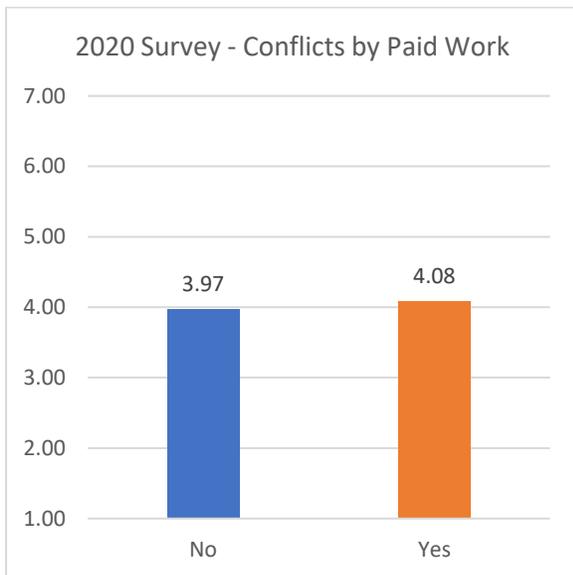
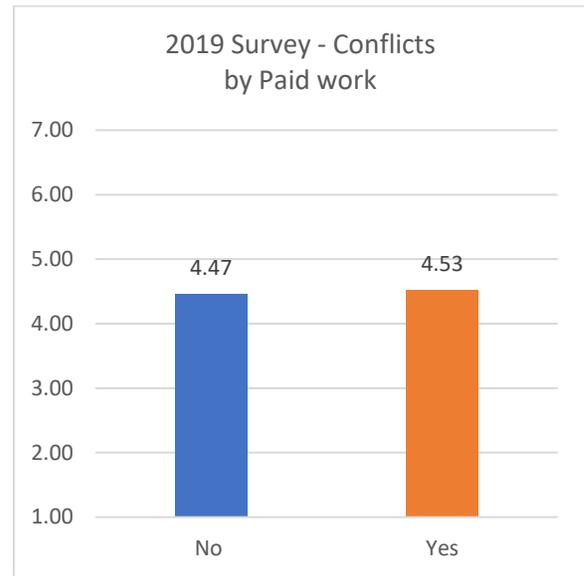
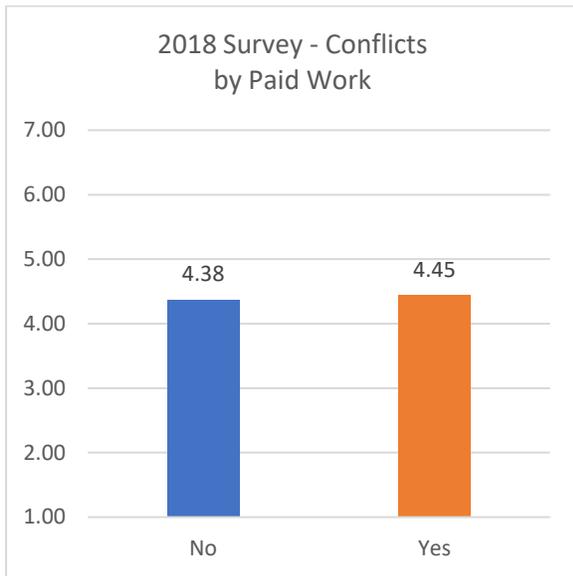
Transfer Status

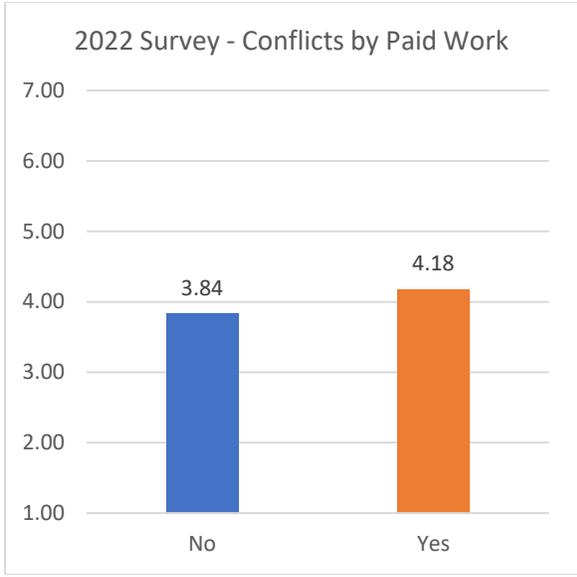




Age

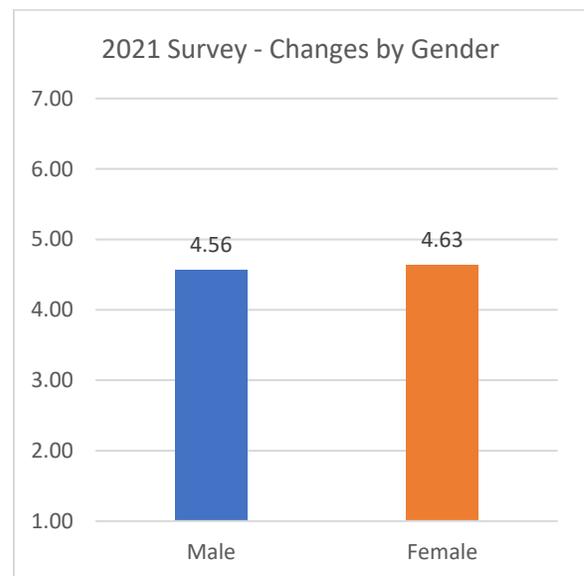
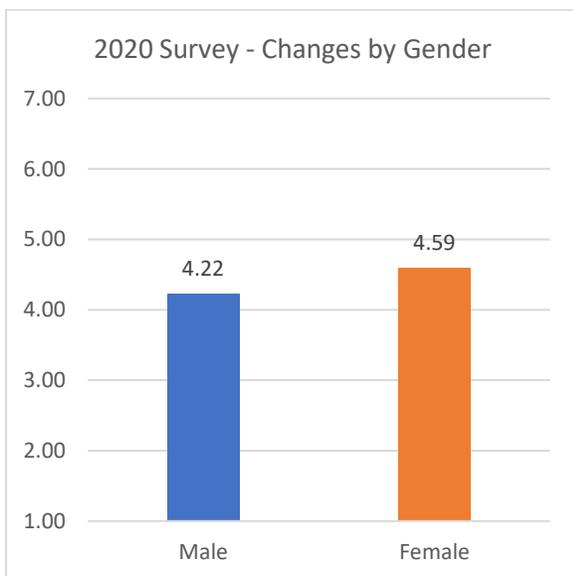
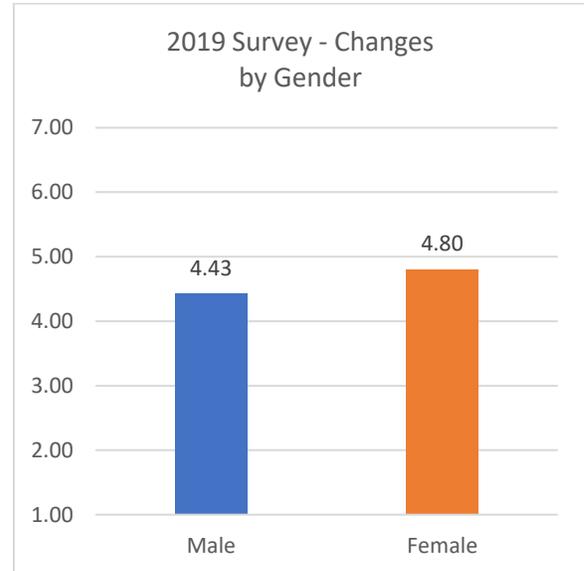
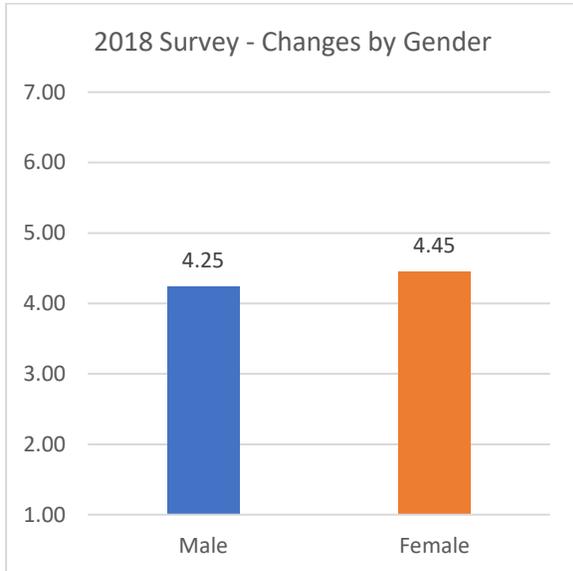


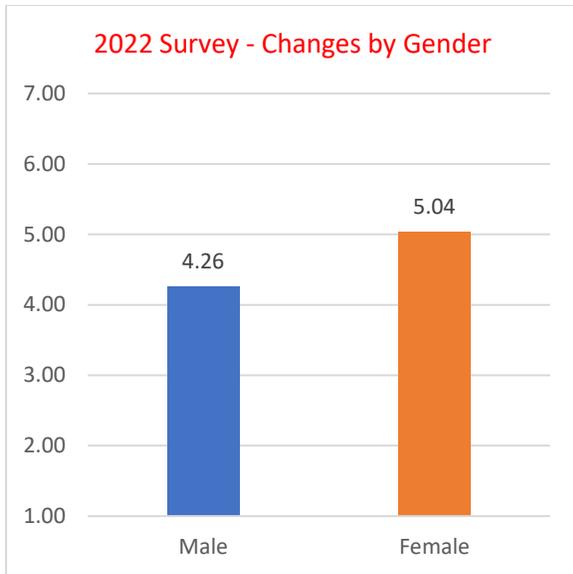
Employment status



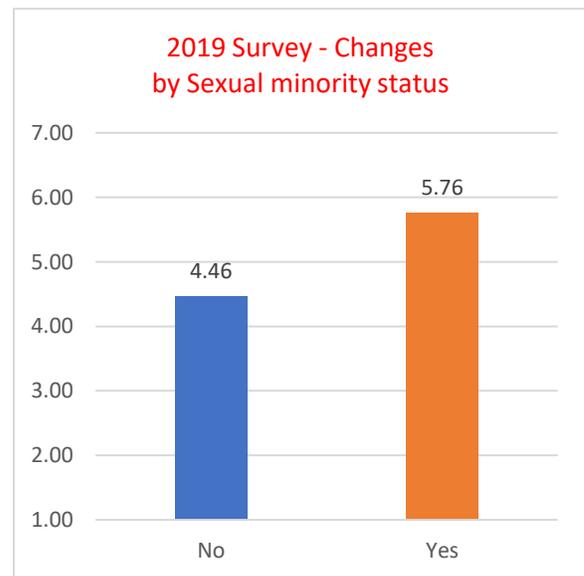
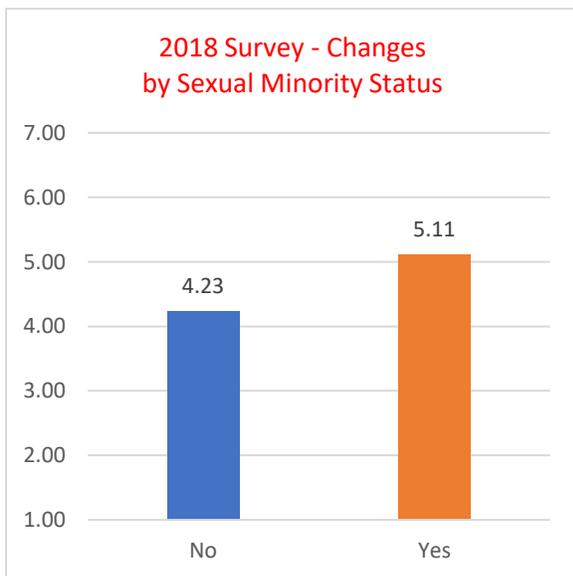
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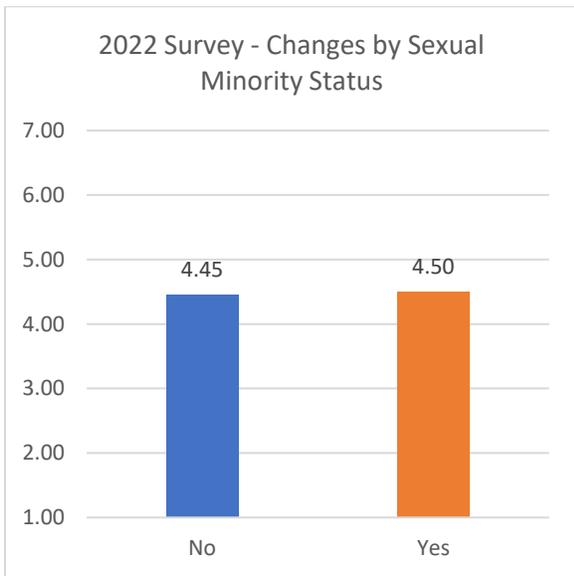
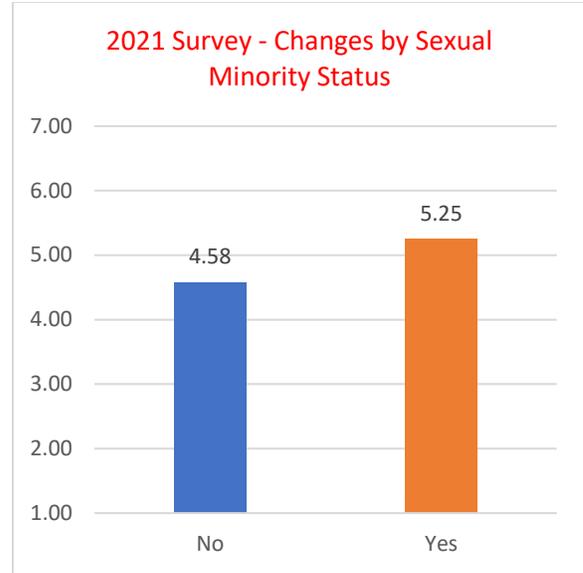
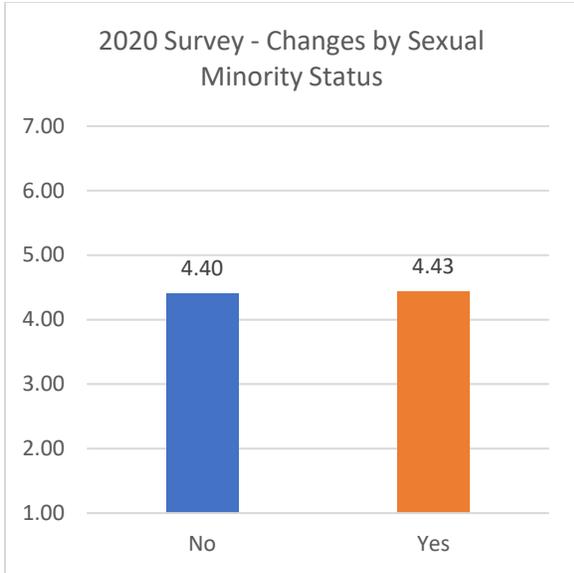
Gender



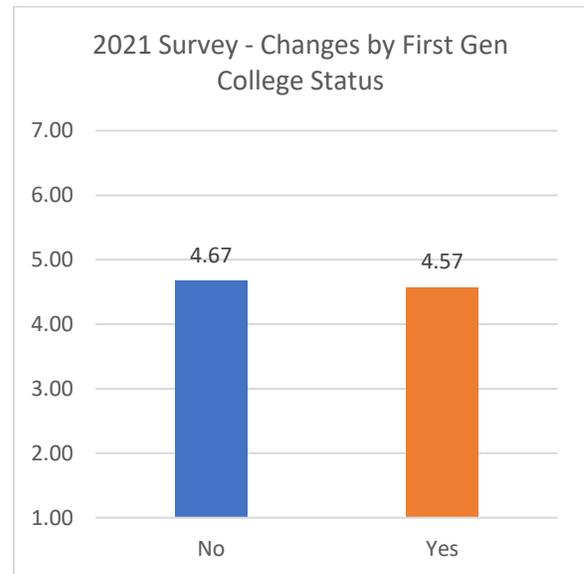
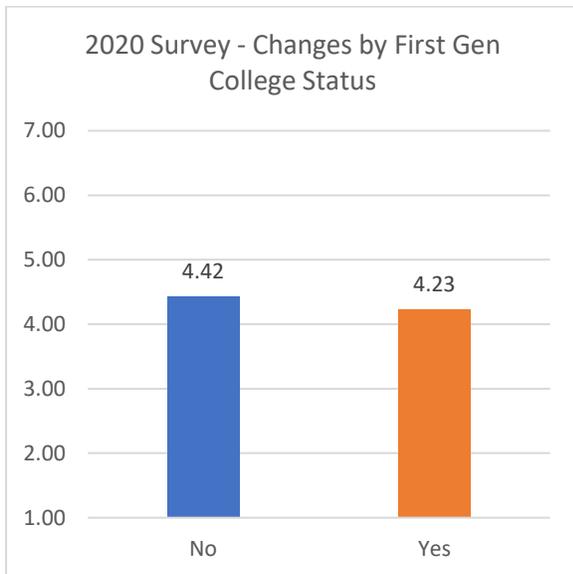
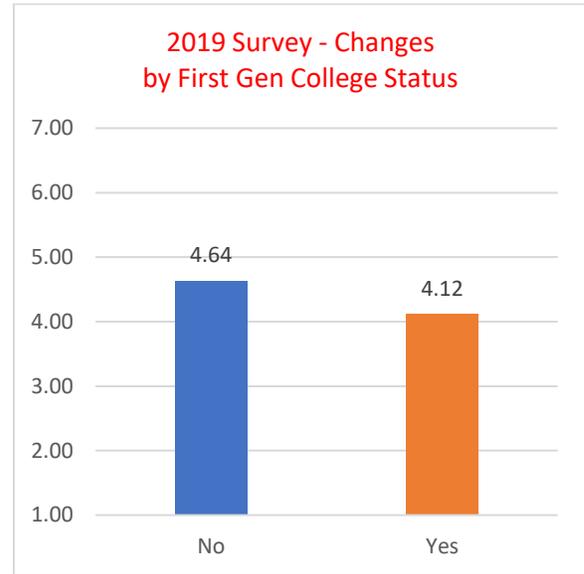
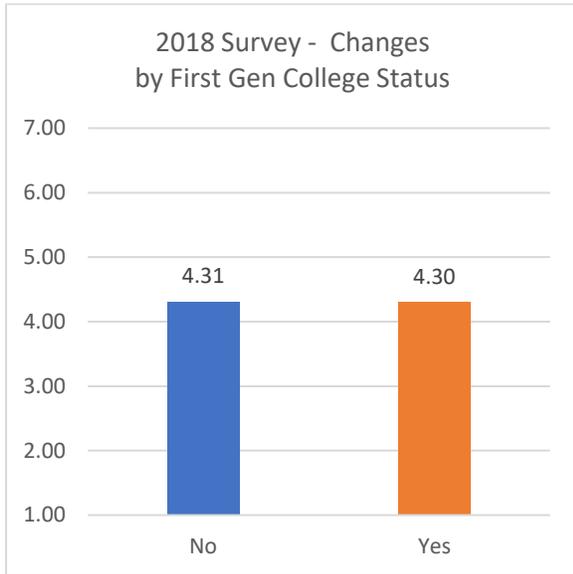


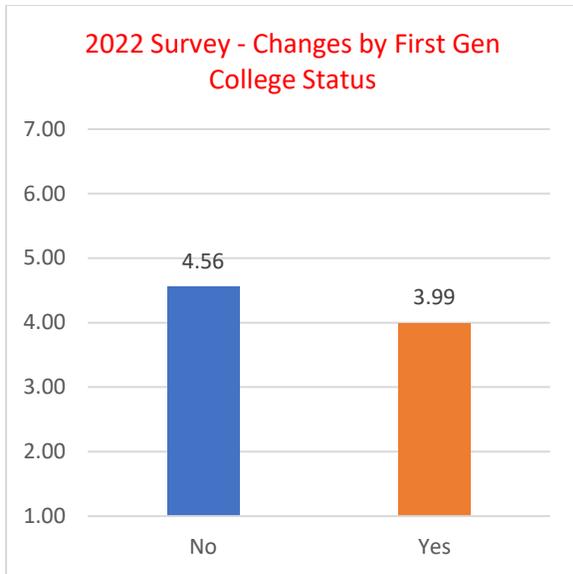
Sexual Minority Status



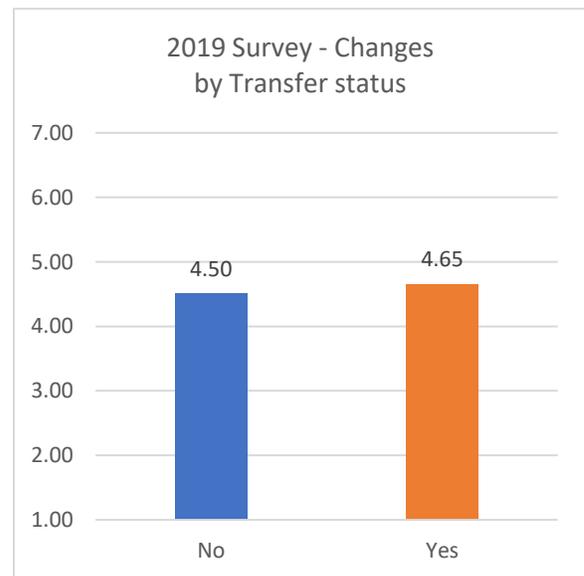
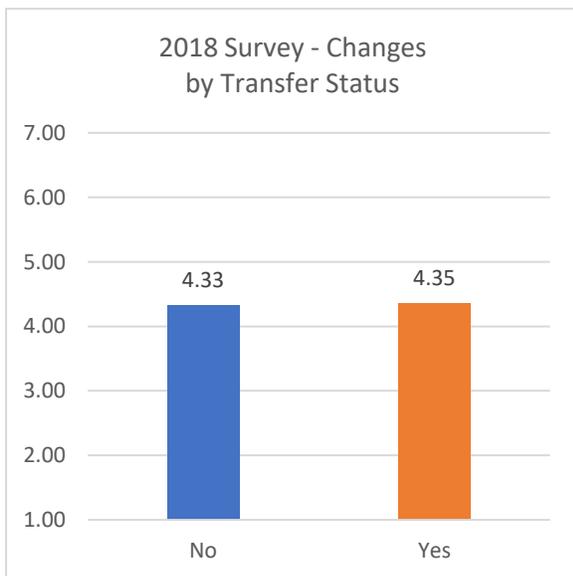


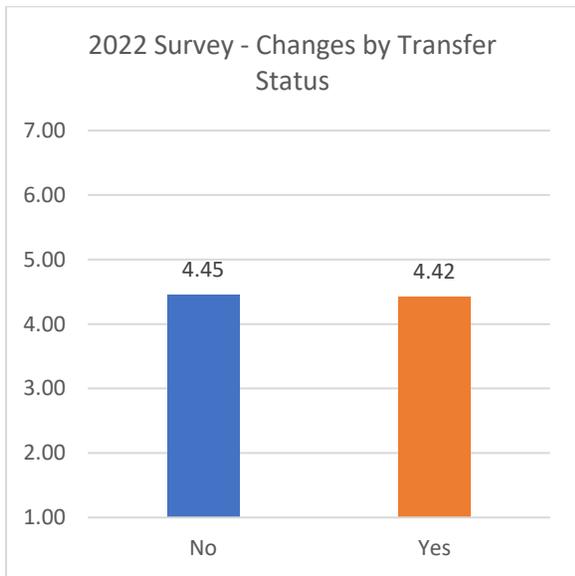
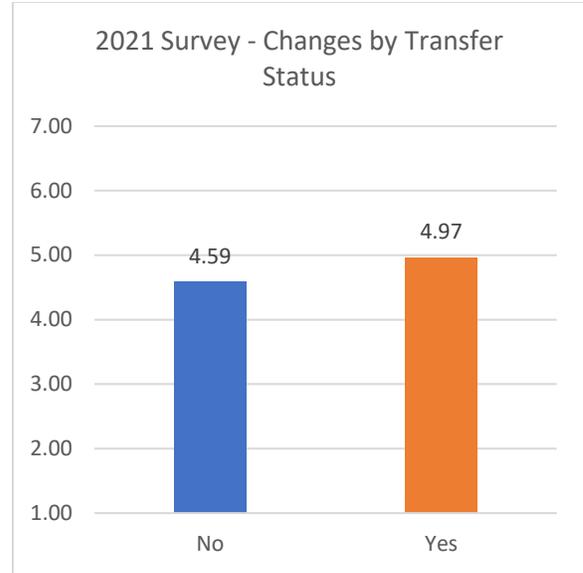
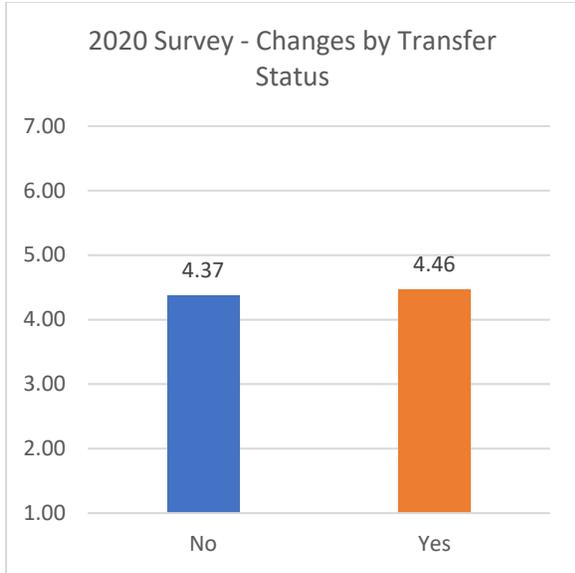
First-generation College Status



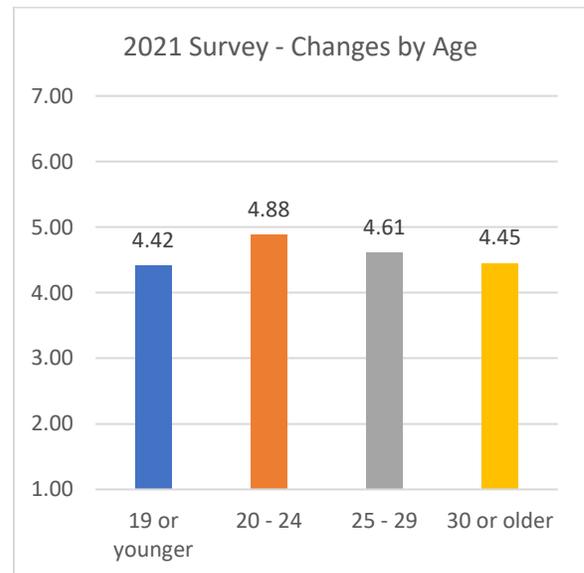
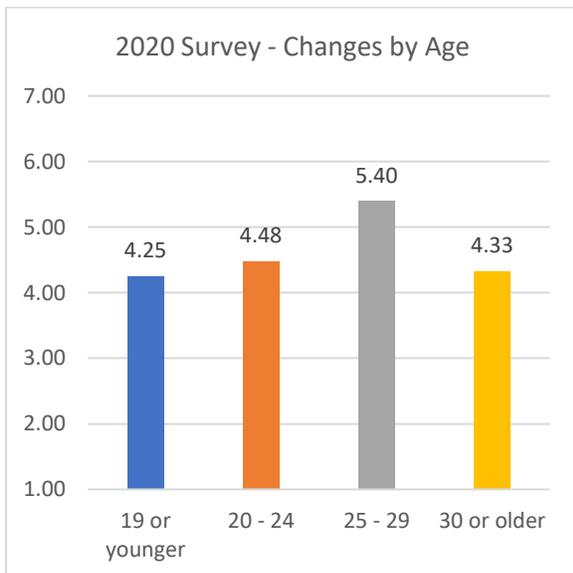
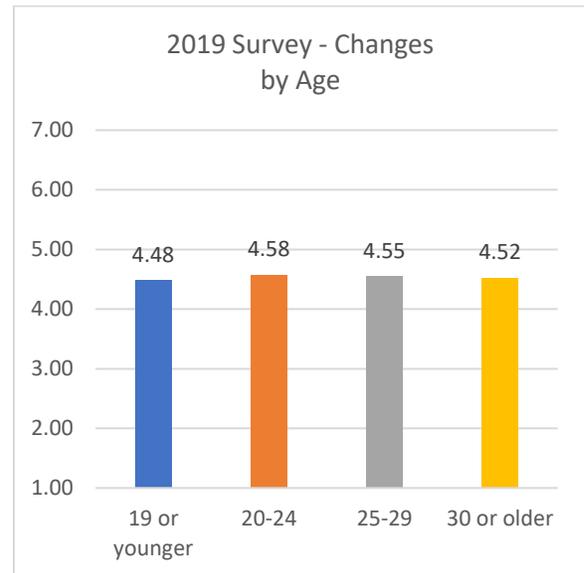
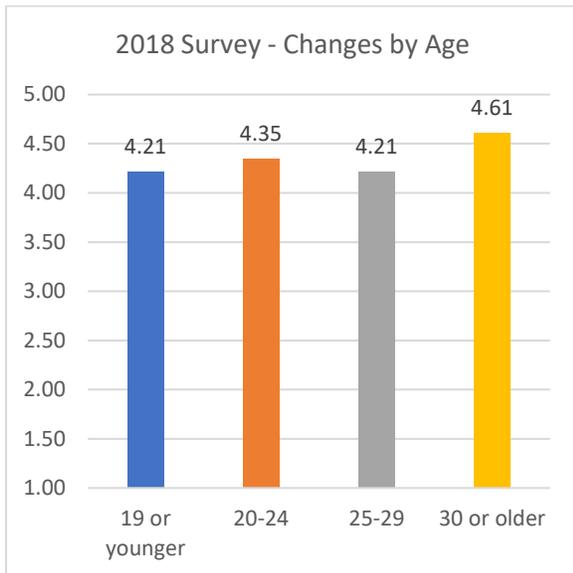


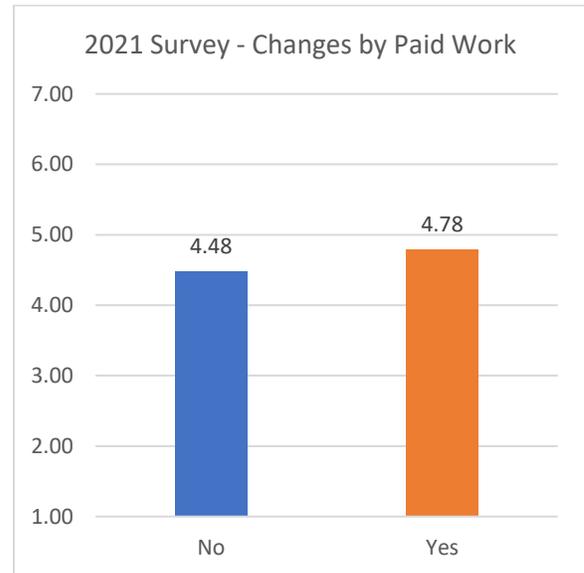
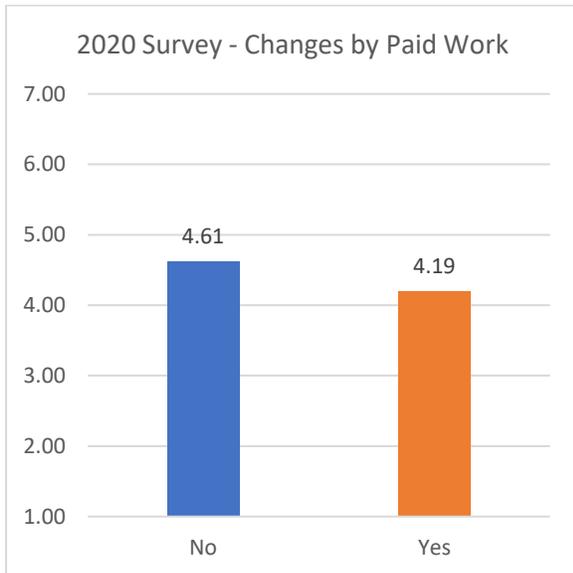
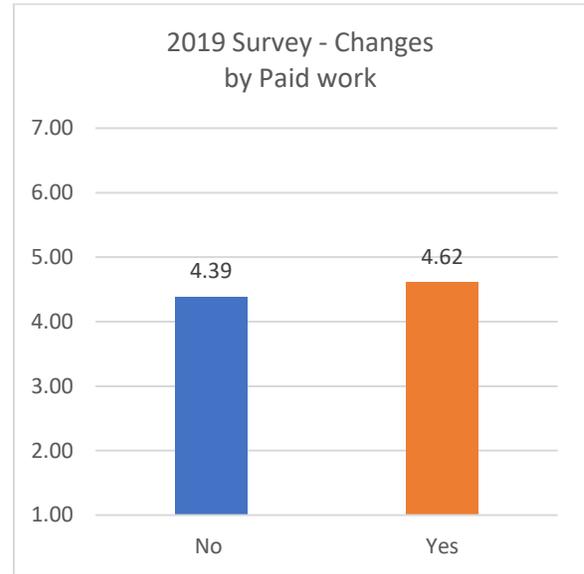
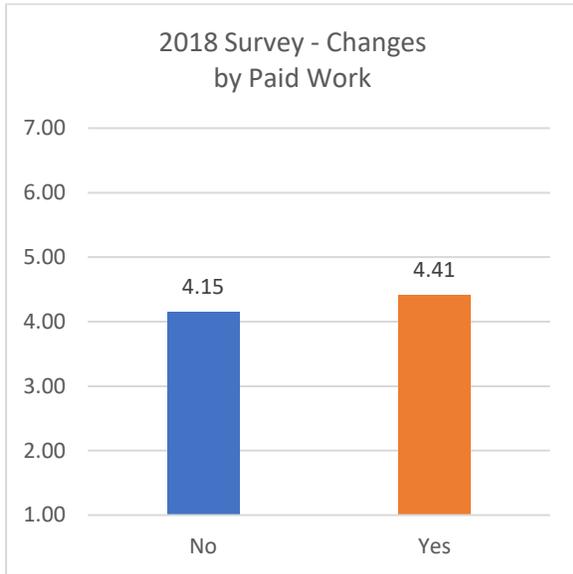
Transfer Status

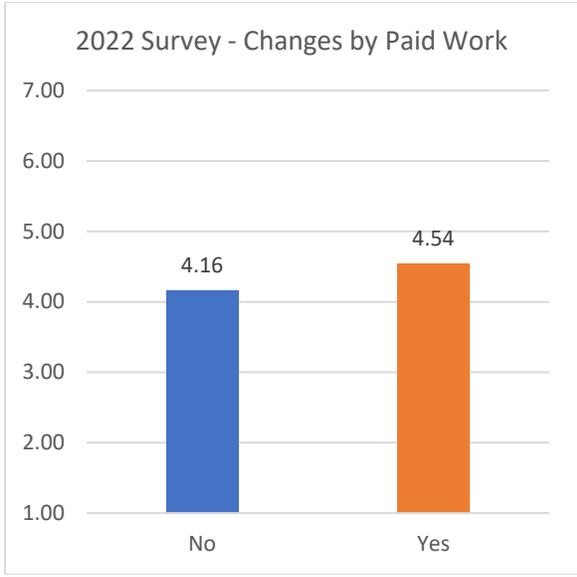




Age

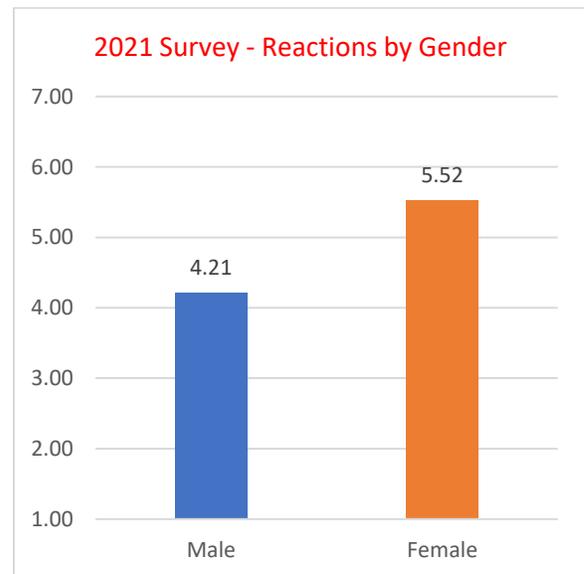
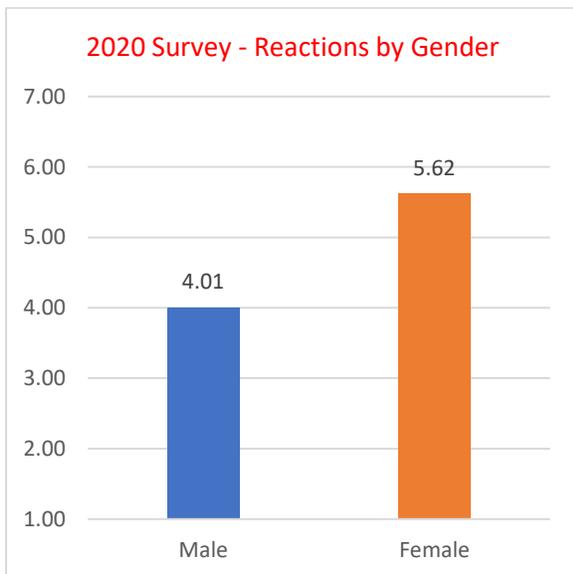
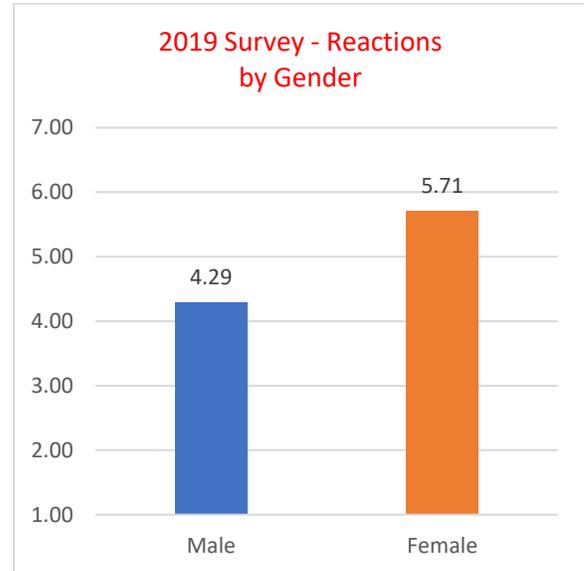
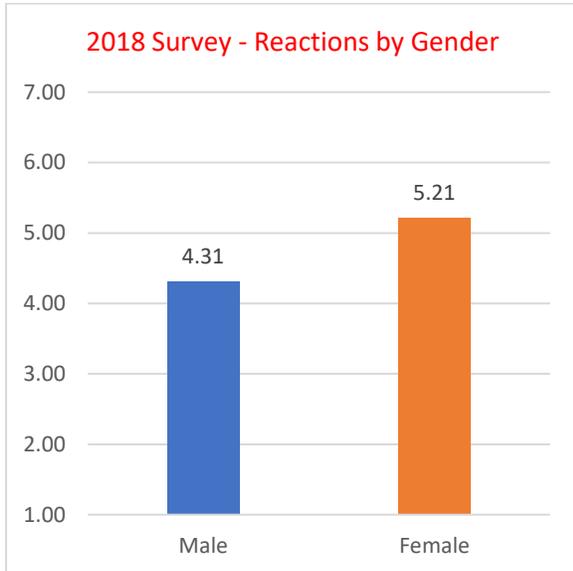


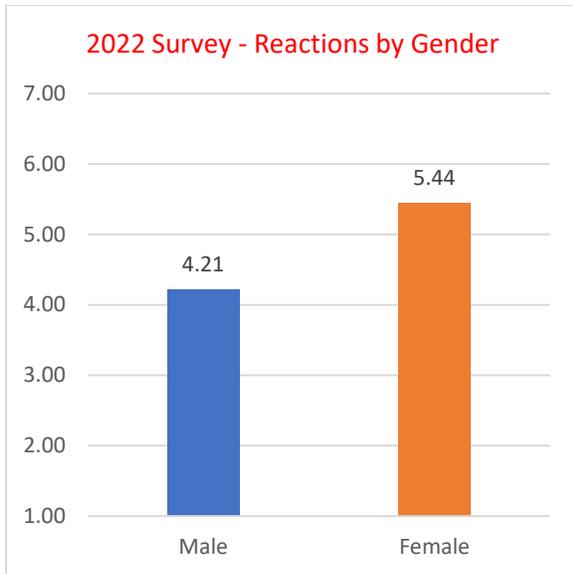
Employment status



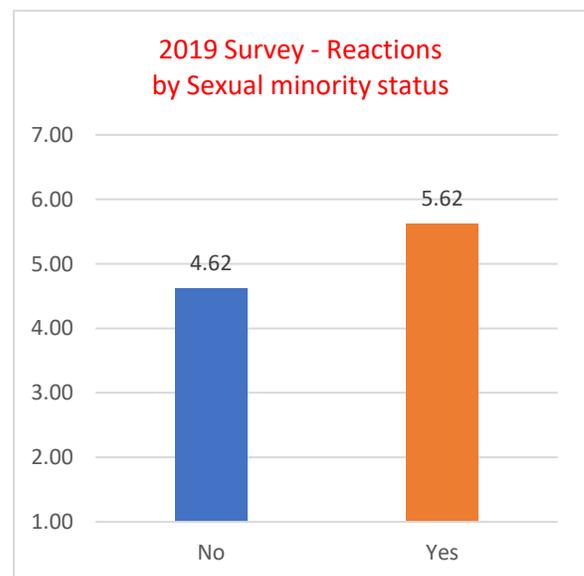
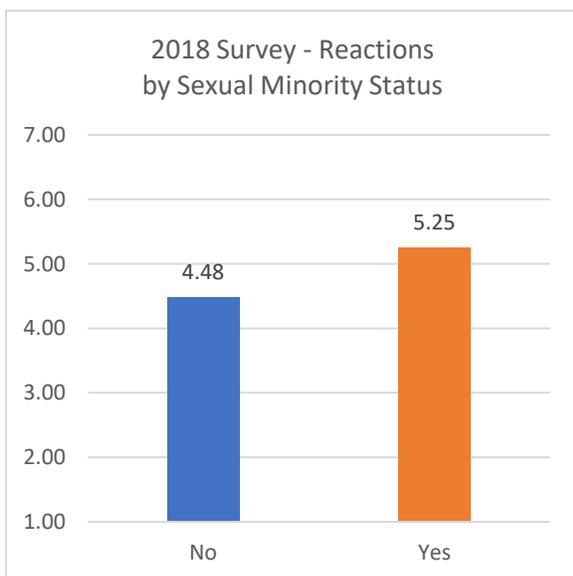
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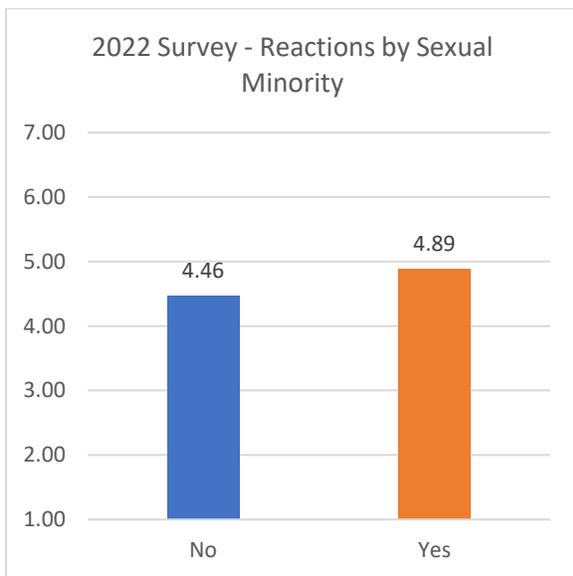
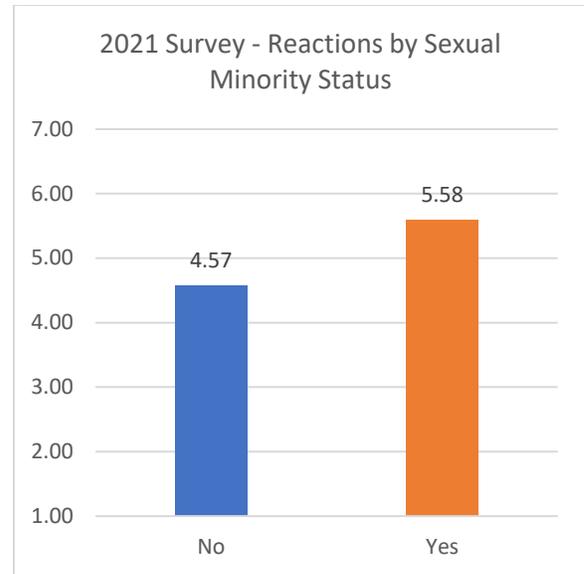
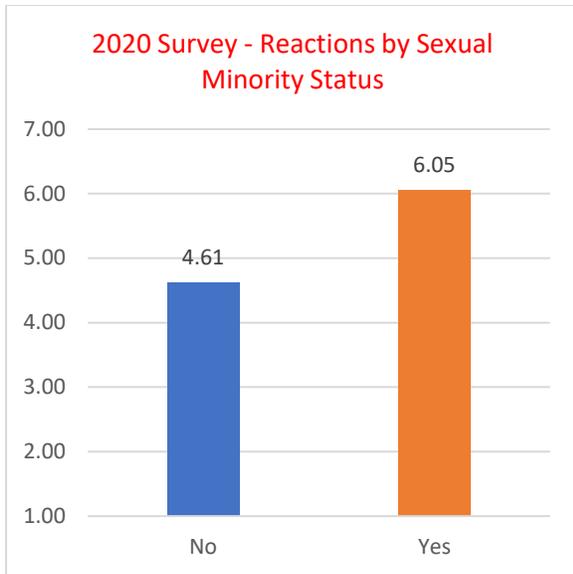
Gender



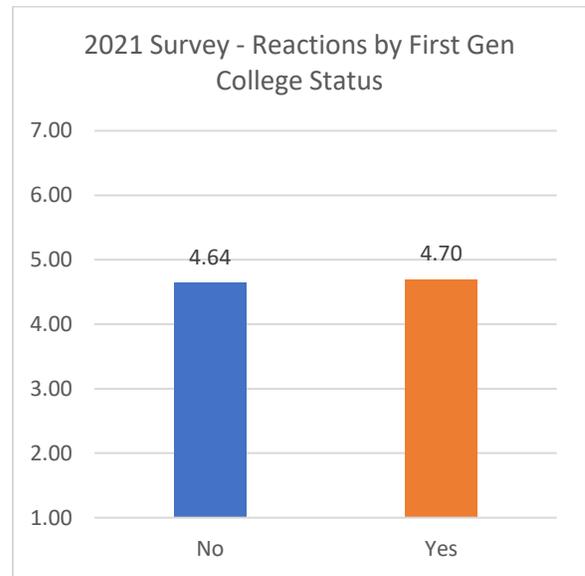
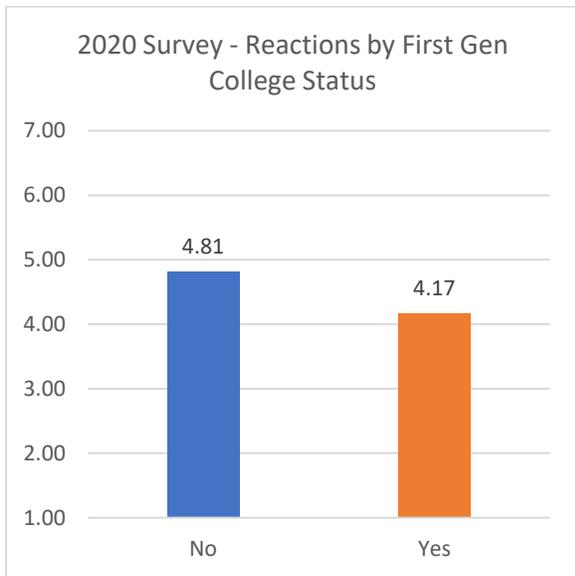
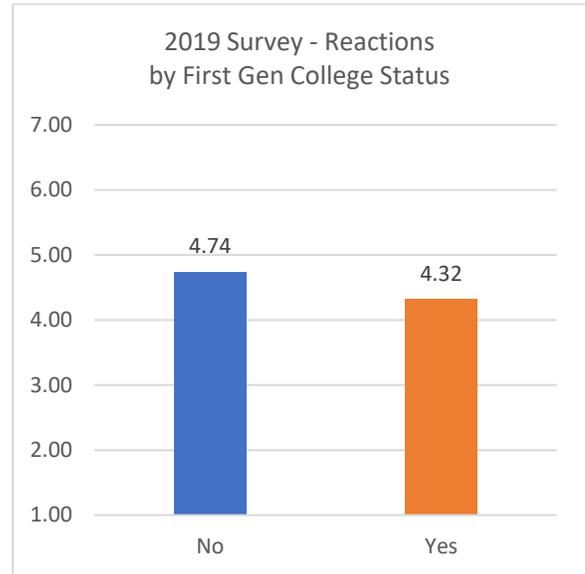
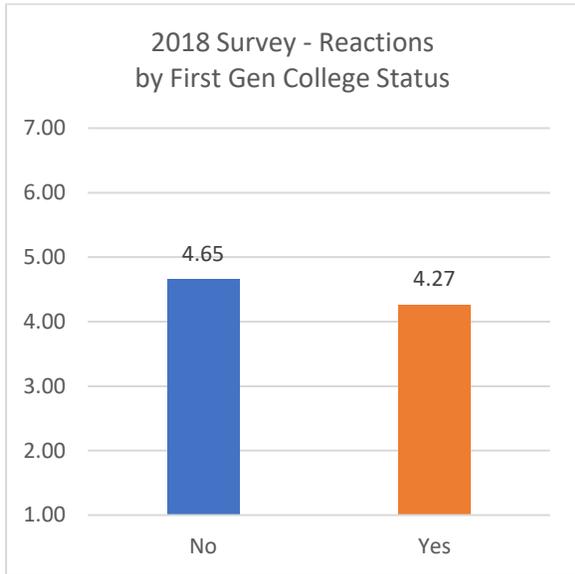


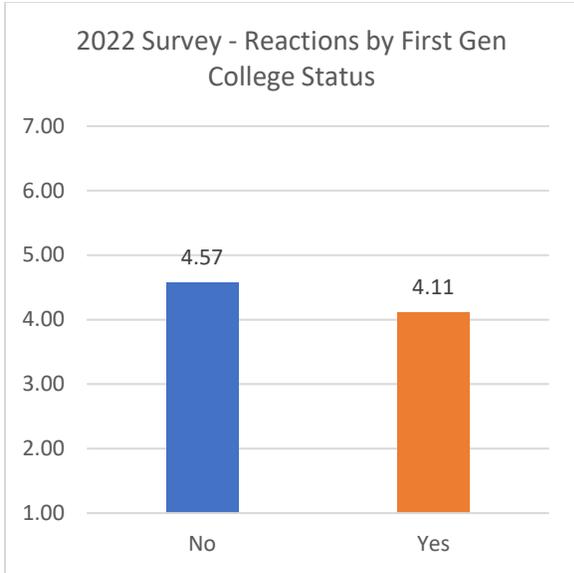
Sexual Minority Status



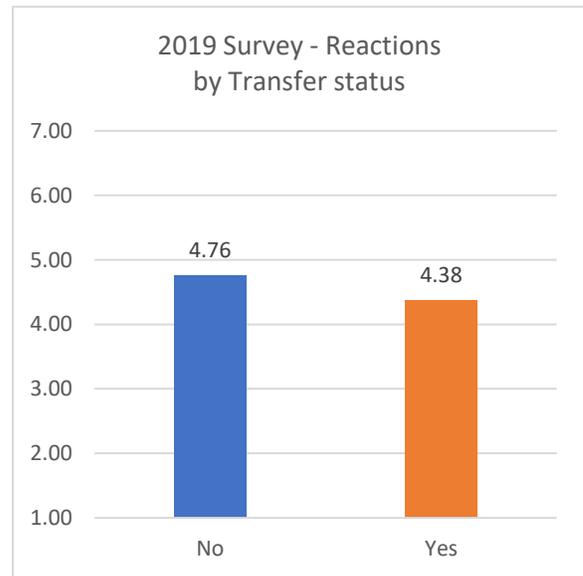
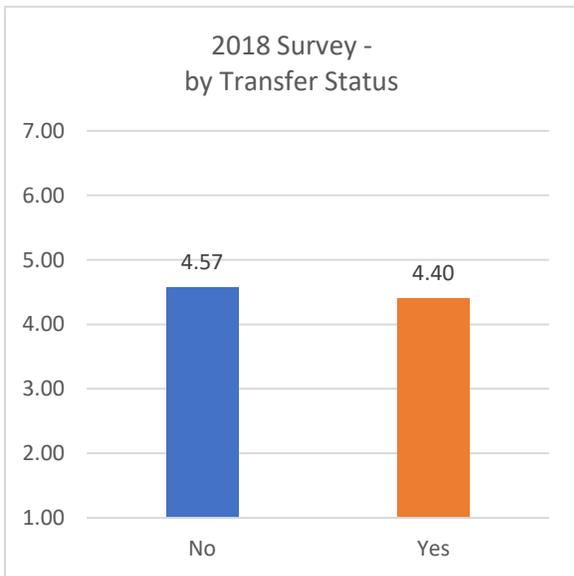


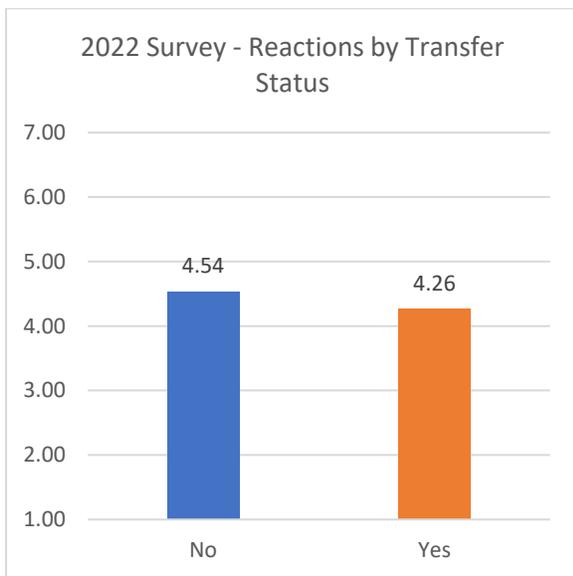
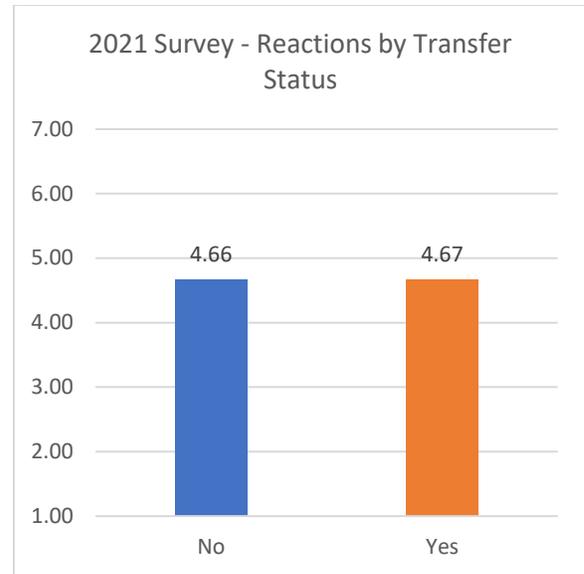
First-generation College Status



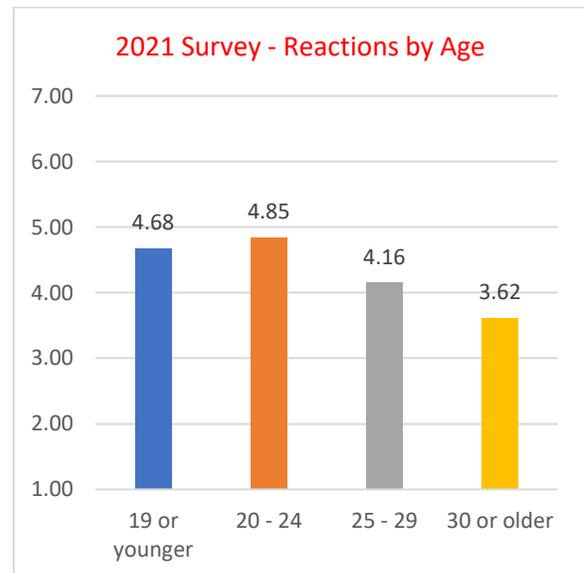
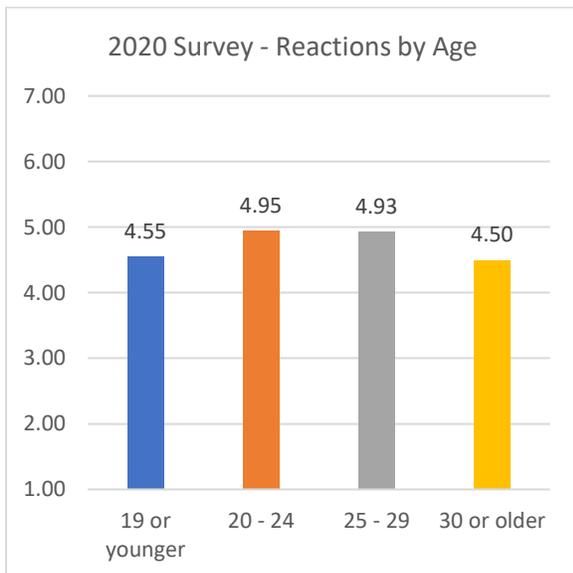
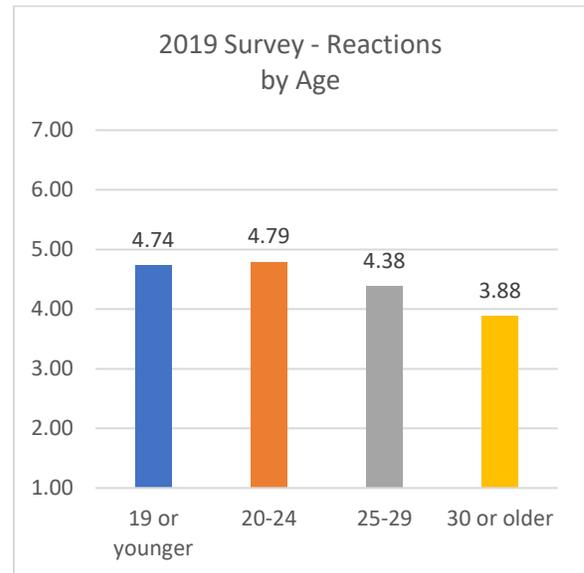
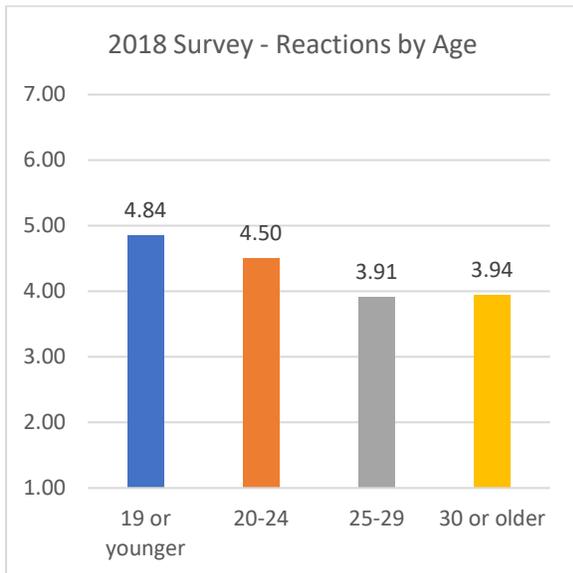


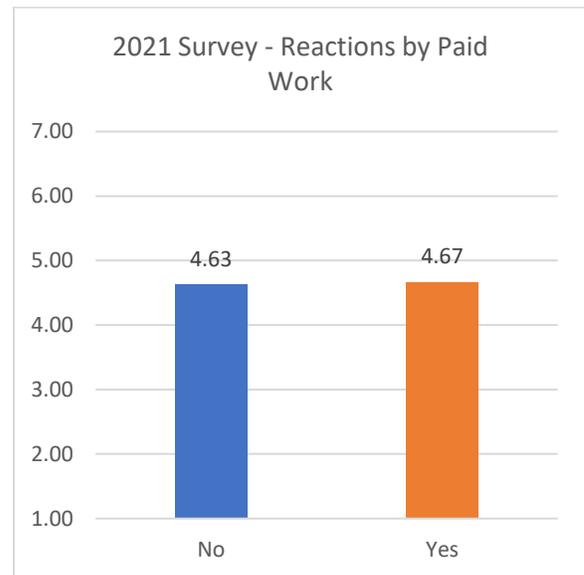
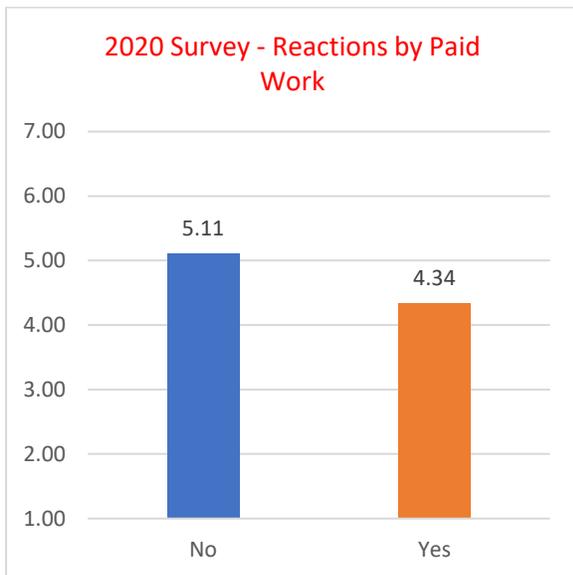
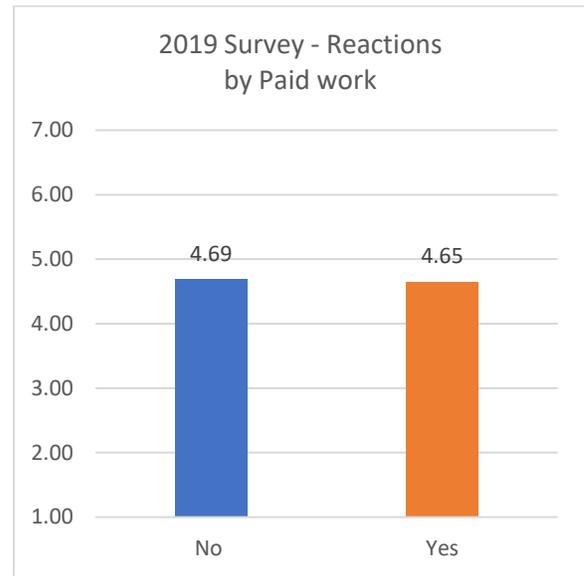
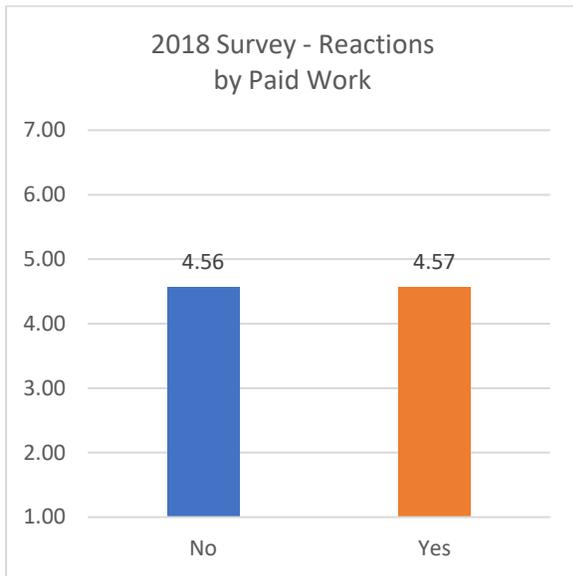
Transfer Status

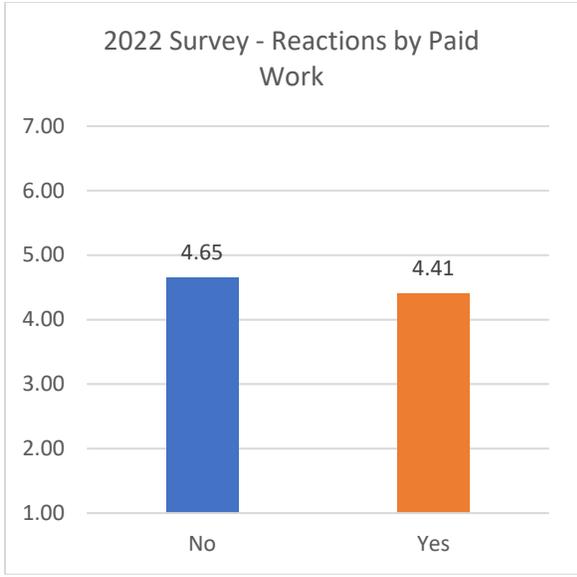




Age

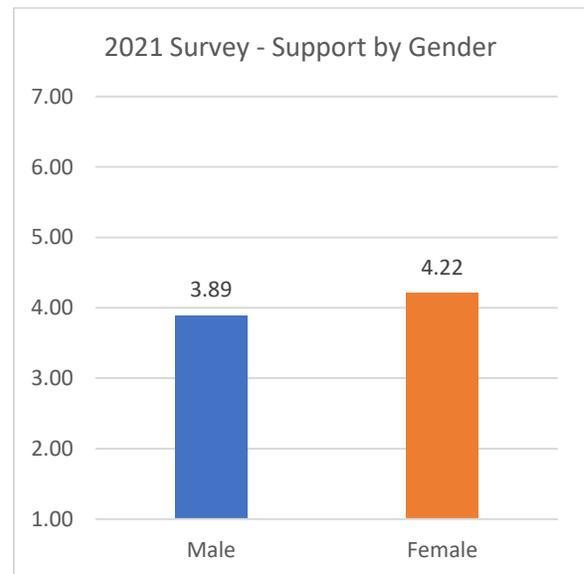
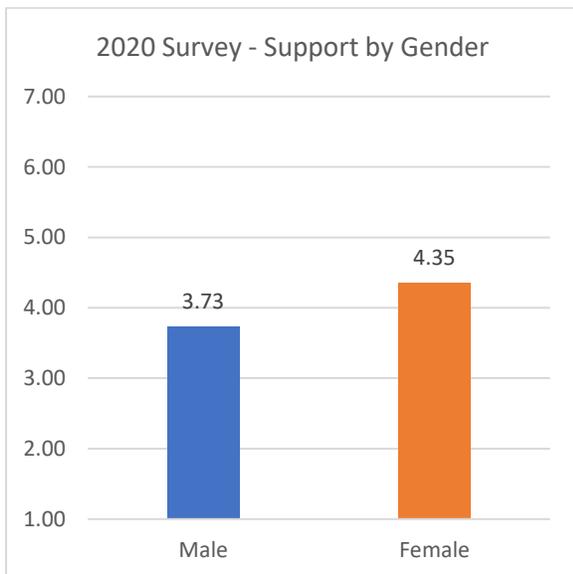
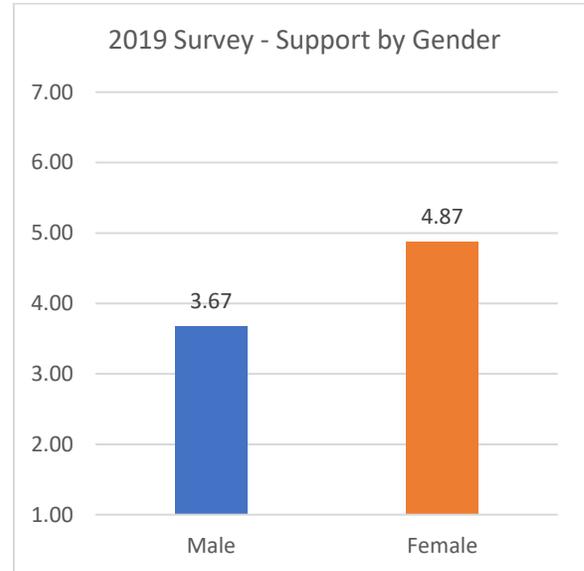
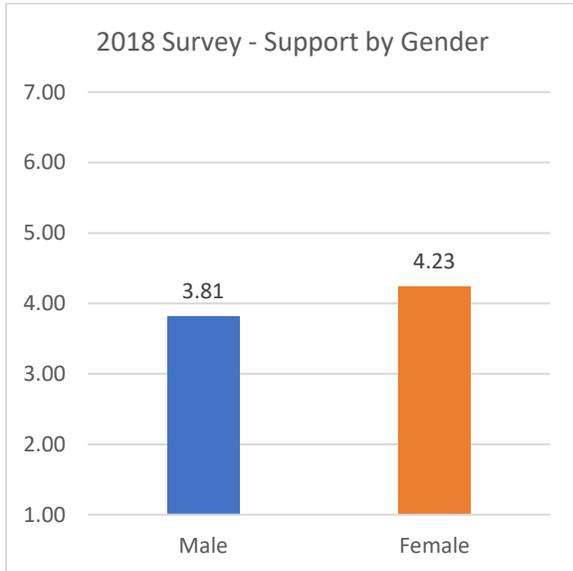


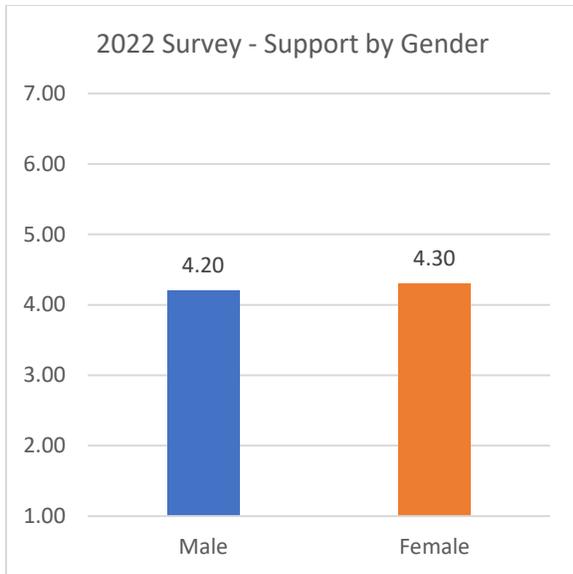
Employment status



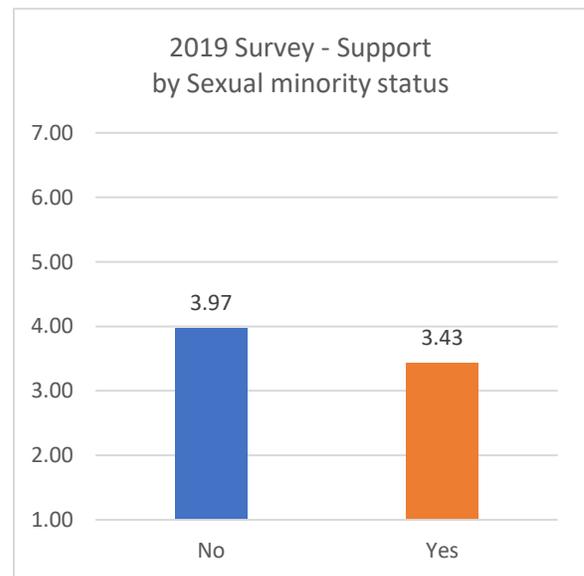
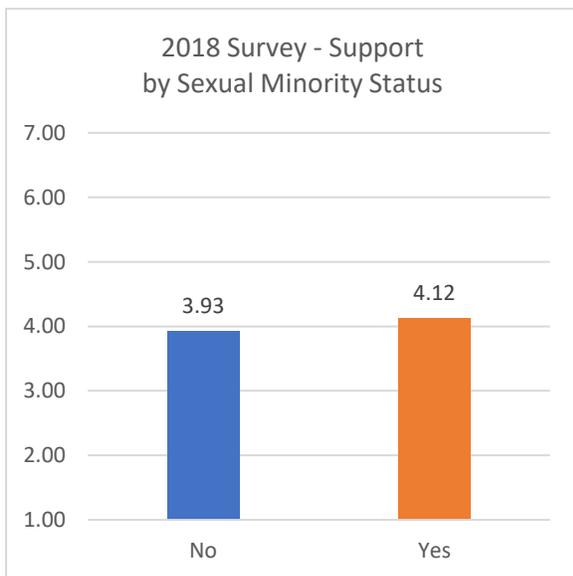
5) Support

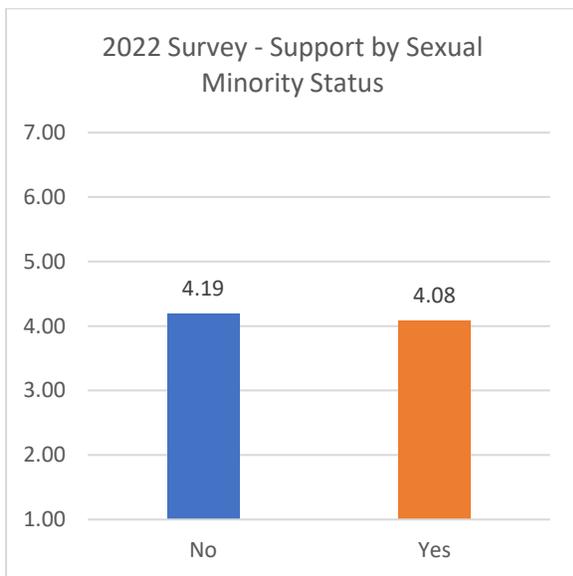
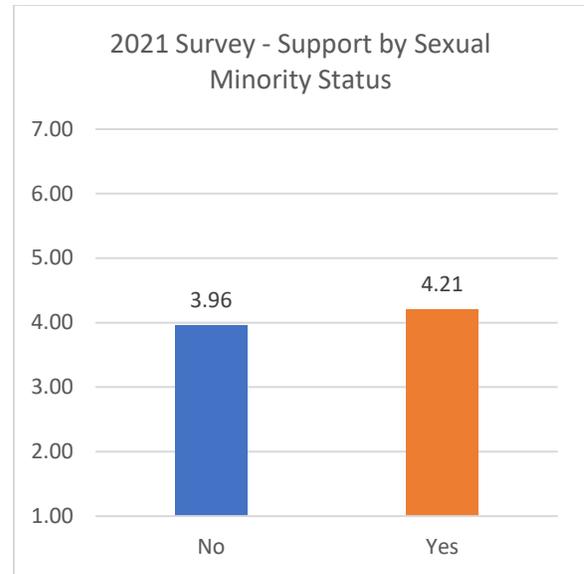
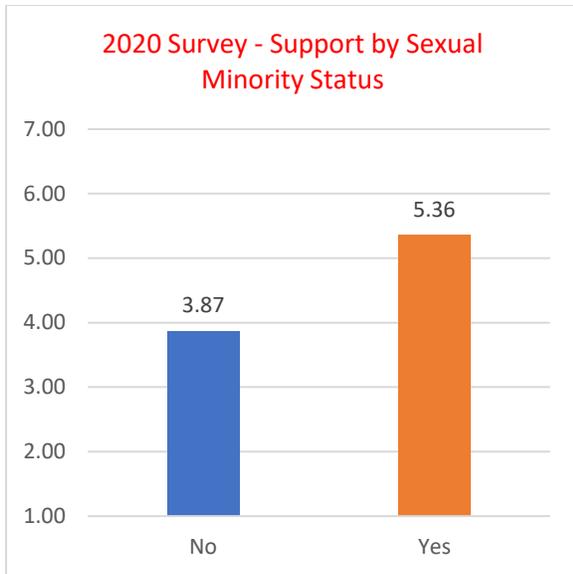
Gender



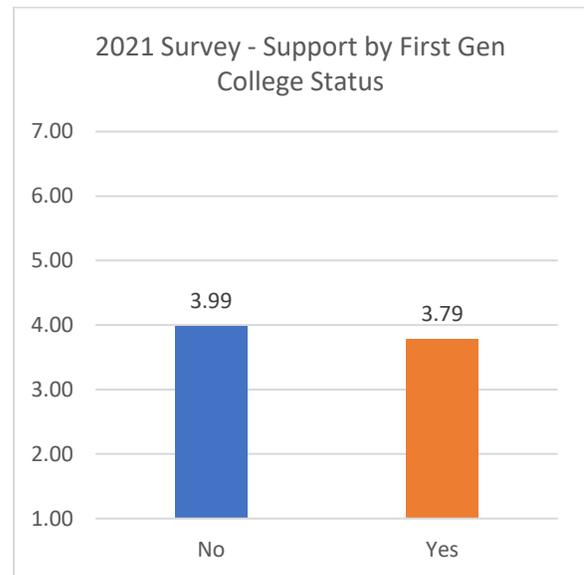
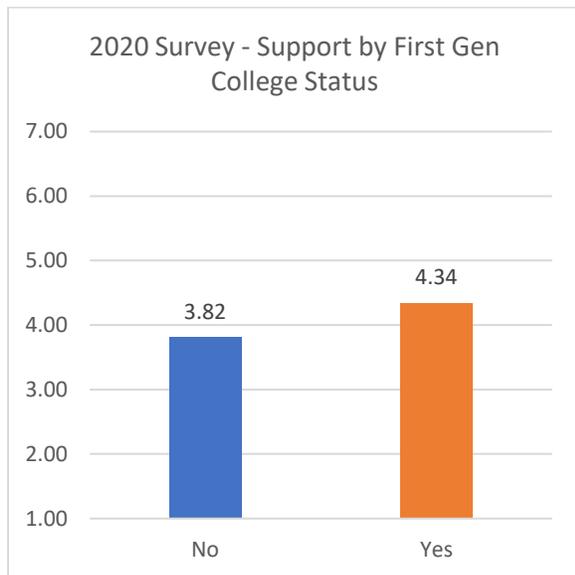
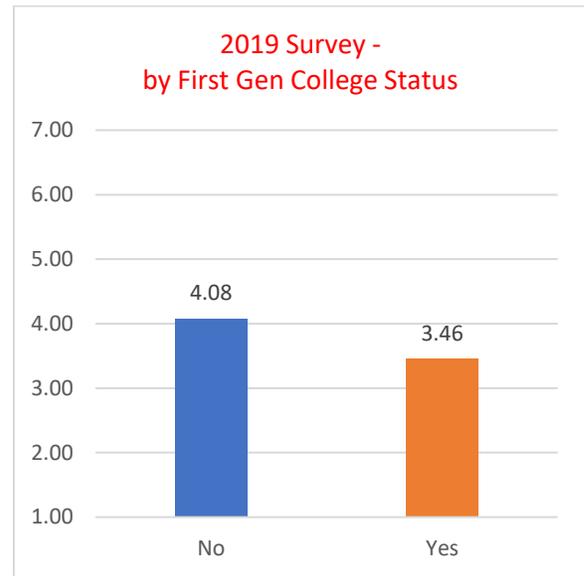
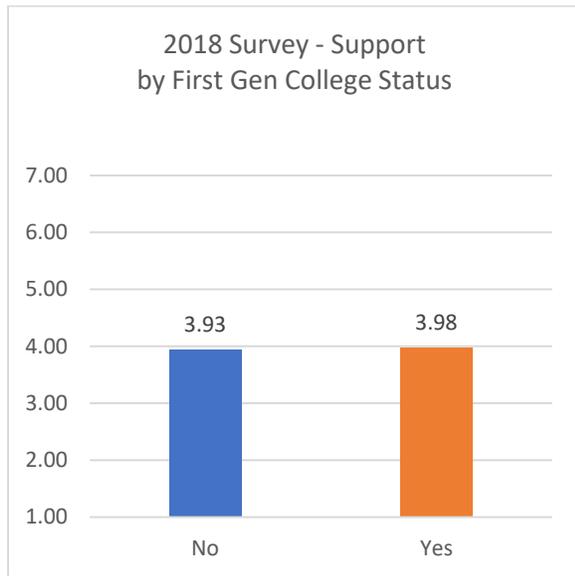


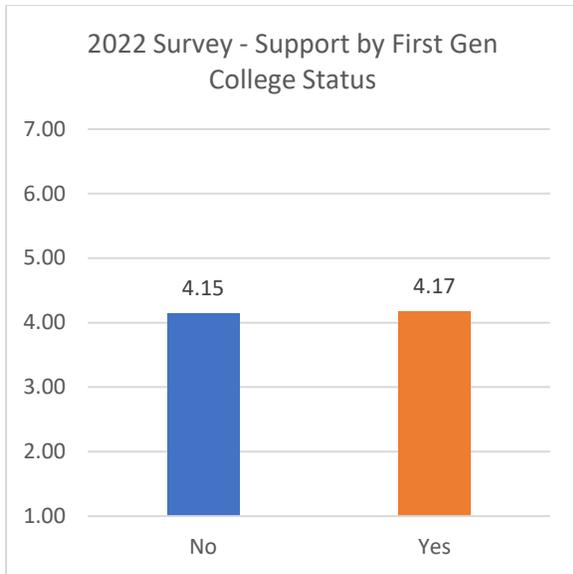
Sexual Minority Status



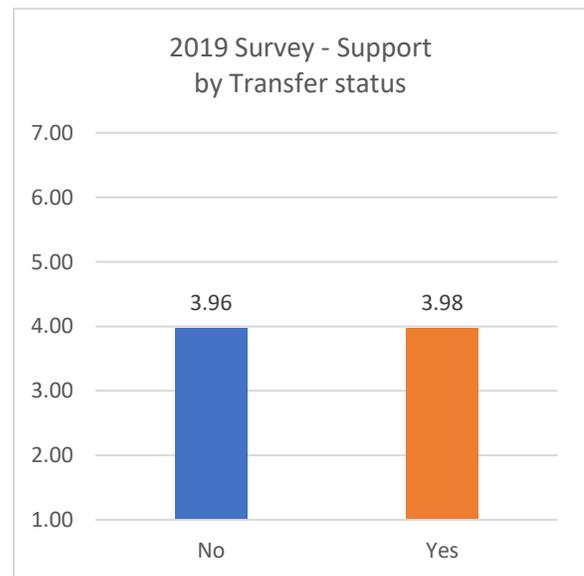
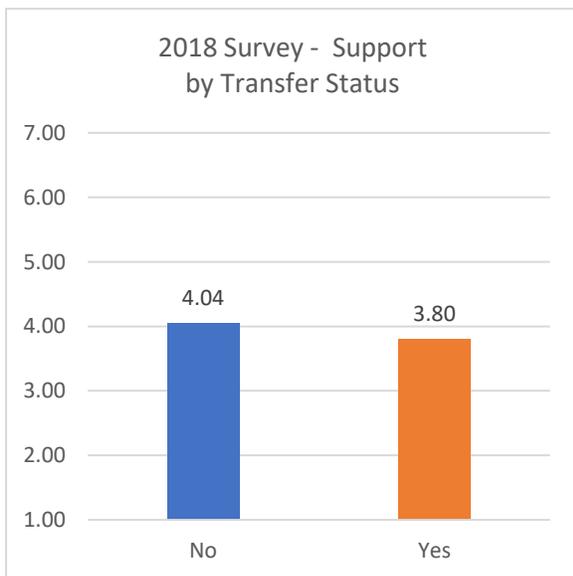


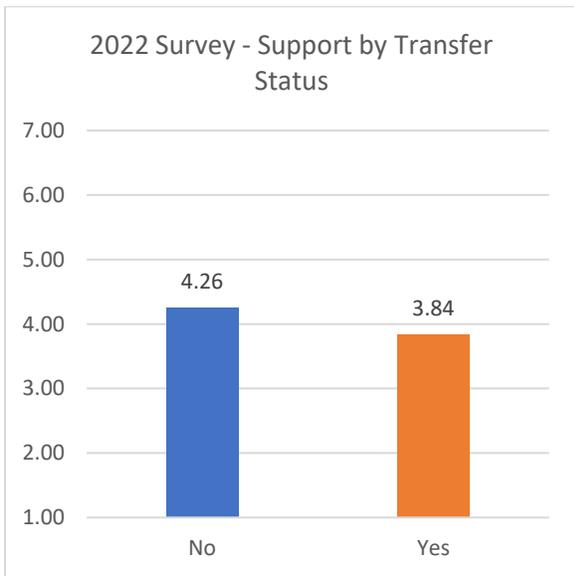
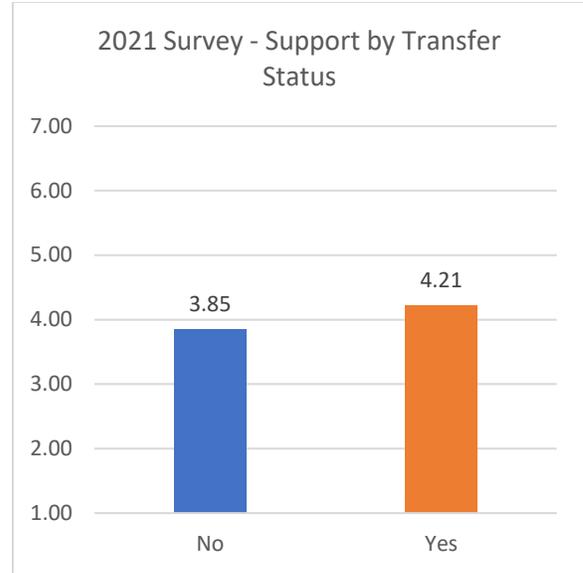
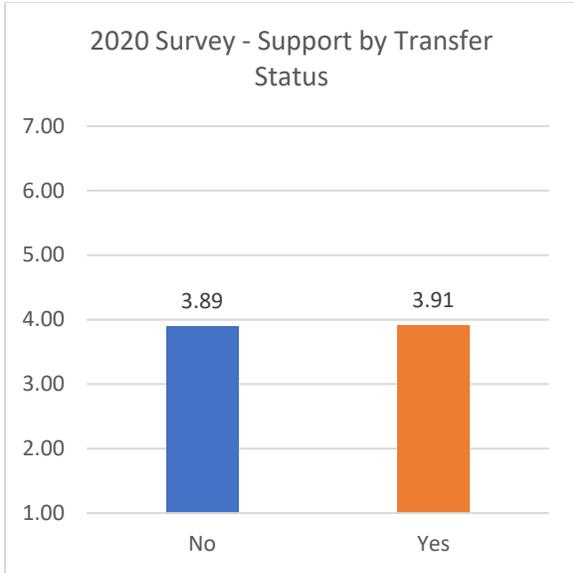
First-generation College Status



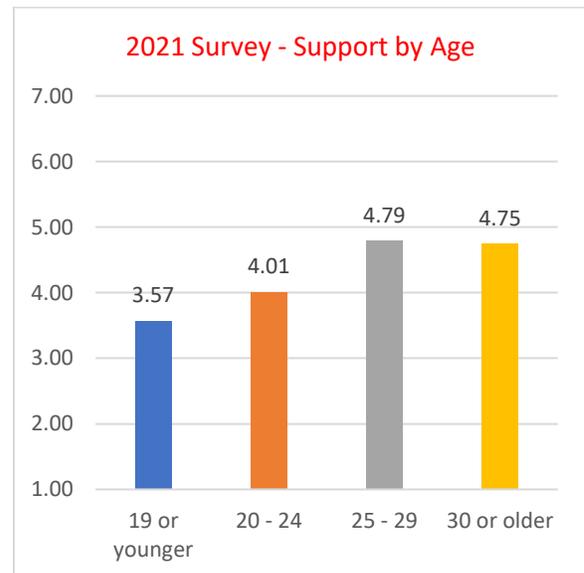
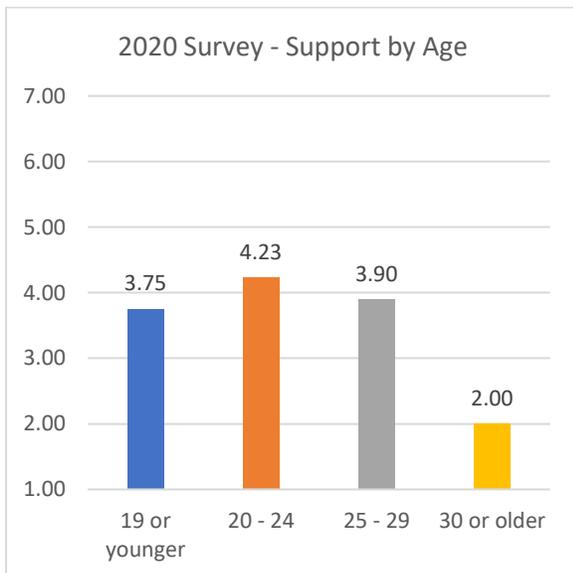
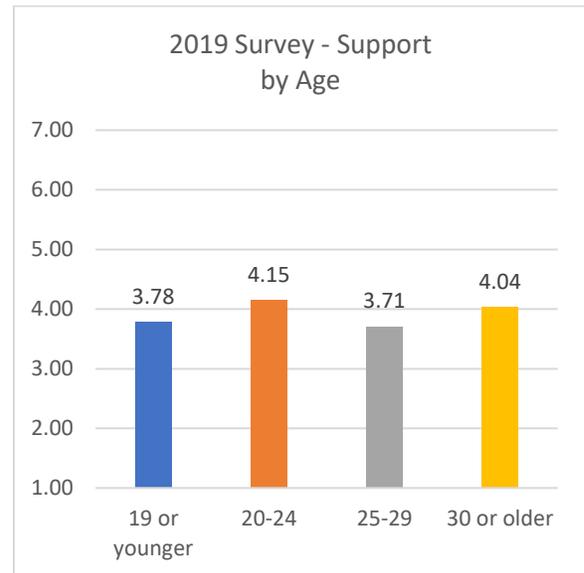
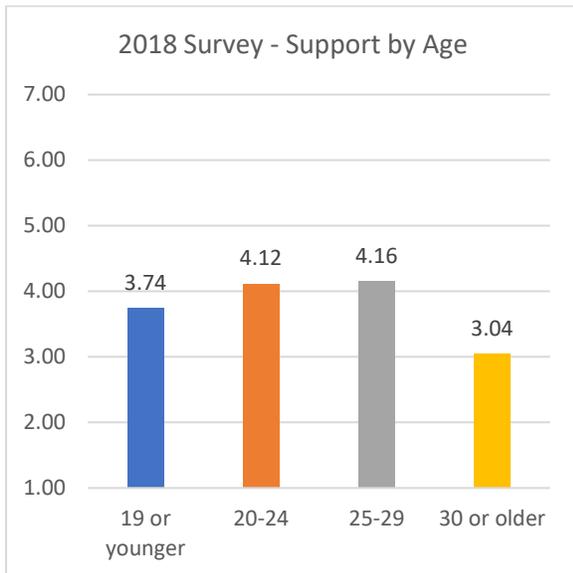


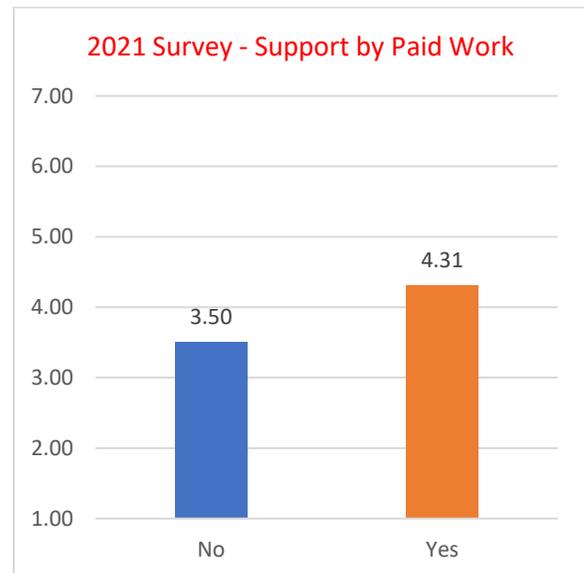
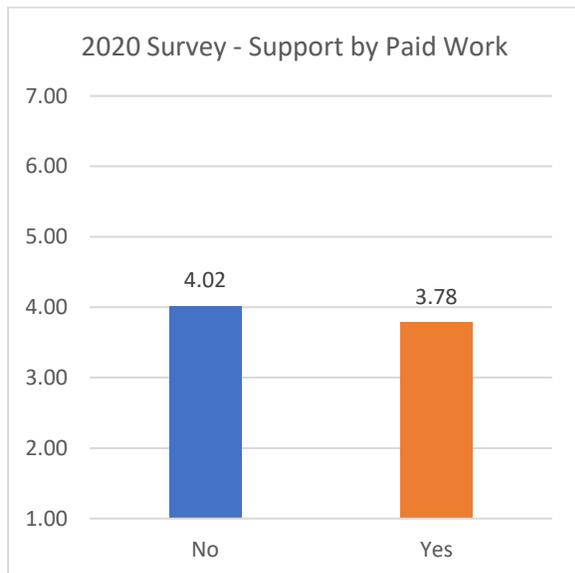
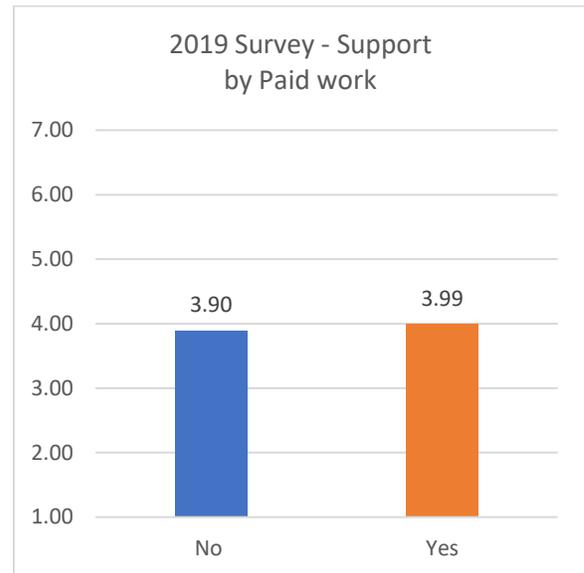
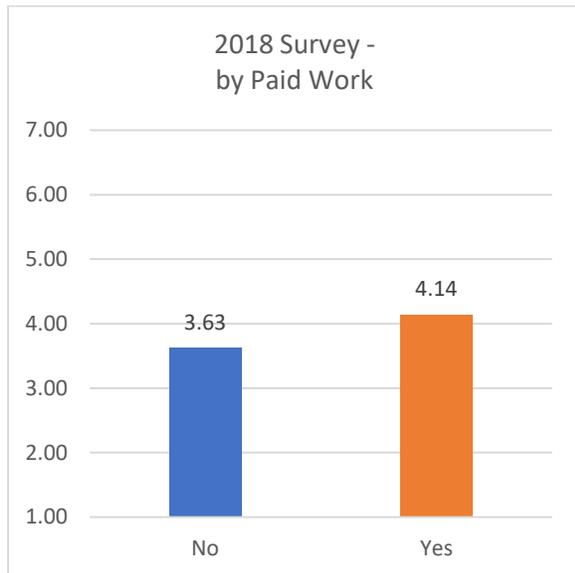
Transfer Status





Age



Employment status

Key Findings and Recommendations

Key findings

- In comparison across departments, the students enrolled in the department of Computer Science report higher levels of perceptions of faculty caring – empathetic faculty understanding; however, the students report significantly lower levels of conscientiousness, grit, meaning and purpose, and connectedness compared to those enrolled in other departments. In addition, CS students are more likely to report a higher level of neuroticism and frustration.
- In changes within departments across year groups, in Spring 2021 survey, students enrolled in the department of Mechanical Engineering and the department of Computer Science report higher levels of neuroticism compared to their peers in the departments who completed the SUCCESS survey from previous years.
- In the department of Civil Engineering, students' perceptions of faculty caring have improved compared to previous years; however, students' average scores of conscientiousness have decreased over time.
- In the analyses of survey data sets from each year across student demographics, female students report significantly higher neuroticism levels than their male peers from Spring 2018 to Spring 2021 surveys. In addition to the higher levels of neuroticism, female students report significantly higher reactions to life stress than male students from Spring 2018 to Spring 2022 surveys. However, their agreeableness was significantly higher than male students across three years (from Spring 2019, Fall 2020, and Spring 2022).
- Compared to sexual minority students, non-sexual minority students report significantly higher levels of belongingness, meaning and purpose, expectancy, and perception. Sexual minority students, however, experience significantly higher levels of life stress toward changes and higher levels of reaction to life stress.
- Compared to students who are not working, students with paid work report significantly higher levels of extraversion in spring 2018, 2019, and 2021 surveys.

Recommendation

- Identify departmental programs and strategies addressing engineering and computing students' socio-emotional challenges during college that may impact student academic performance, retention, and graduation
- Investigate the disparity by gender in several non-cognitive and affective factors, particularly, neuroticism and experiences with life stress and build the infrastructure improving female students' college success in engineering and computing fields
- Examine and strengthen support systems for sexual minority students to improve their non-cognitive and affective profiles
- Ensure equal opportunities and infrastructures for students who work for pay off campus

About the Authors

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Dr. Kim is an Assistant Professor of Research at the Center for Education Research and Policy Studies (CERPS), which resides in the College of Education at UTEP. She co-leads the Data Management Team of Computing Alliance of Hispanic-Serving Institutions (CAHSI), one of only five of NSF's inaugural INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) Alliances. She earned her doctorate in Education from the University of Iowa. During her time as a graduate student, Dr. Kim was awarded both the William Duffy Schools, Culture, and Society Doctoral Fellowship and the 2017-2018 Ballard and Seashore Dissertation Fellowship. Her research uses sociological perspectives and quantitative methods to study educational equity and racial and socioeconomic diversity in higher Education, focusing on the experiences and persistence of students from minoritized communities in STEM fields. Her current research focuses on the higher education experiences and trajectories of Latinx students in computing fields. She has been involved with several NSF projects advancing inclusion, diversity, and equity in engineering and computing fields. She has published and co-authored several articles published in the following journals: Educational Evaluation and Policy Analysis, Educational Policy, Journal of Student Affairs Research and Practice, Journal of College Student Development, and Teachers College Record.

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Andres Segura is a third-year undergraduate student majoring in Computer Science. He is looking forward to working as an intern for Google in the summer of 2024 and plans to attend graduate school after graduation.

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Gabriel Miki is currently a junior in the University of Texas at El Paso, in a Computer Science major. After graduation, he plans on getting a masters' degree in education through the Noyce Teaching Fellowship program, so that he can become a teacher.

Mayra Robles

Mayra Robles is a sophomore in her undergraduate studies majoring in Computer Science with a concentration in Software Engineering. She has enjoyed her experience at CAHSI because it has allowed her to learn valuable research skills. After her undergraduate studies, Mayra plans to continue her academic career by attending grad school for nuclear physics.

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