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## Maximizing the Academic and Professional Success of First- Generation College Students in Biomedical Engineering

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**Maximizing the Academic and Professional Success of First-  
Generation College Students in Biomedical Engineering**

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Department of Biomedical Engineering



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## **Abstract**

Although efforts to increase the inclusion, retention, and success of first-generation college students (FGCSs) in research universities have resulted in noticeable progress, FGCSs still feel academically challenged, isolated, and show more anxiety and depression compared to non-FGCSs (1). Moreover, FGCSs may possess additional underrepresented identities that exacerbates the problem. There is more risk of dropping out of academic programs for FGCSs enrolling in STEM degrees, especially those of more multidisciplinary nature such as Biomedical Engineering (2-4). From the overall population of the State of Arkansas, only 23.3% have a bachelor's degree or higher which is the third least percentage in the United States (5). Ensuring that STEM FGCSs at the U of A succeed academically and professionally is essential to both increasing the STEM higher education turnover and decreasing the poverty in Arkansas; since gaining a STEM degree is highly linked to social and economic mobility for first-generation college students (6). There is a critical need to identify effective strategies that can lead to the academic success of FGCSs in multidisciplinary STEM fields. In the absence of such strategies, FGCSs will continue to struggle academically and show a continued less representation in the critically important STEM fields.

The goal of this study is to identify effective strategies that lead to the inclusion and success of FGCSs in multidisciplinary STEM fields. Our hypothesis is that various styles of mentorship and coaching will provide academic, and professional guidance for FGCSs that leads to an enhanced sense of inclusivity and, ultimately, their retention and success in the STEM field. We identify the effect of assigning a faculty mentor combined with an academic coach, or a peer mentor combined with an academic coach on the success of FGCSs attending two core classes in the Biomedical Engineering department at U of A. The two selected classes (Sophomore level: Biomechanical Engineering and Junior level: Biomolecular Engineering) are traditionally defined as challenging classes. Data was collected from the FGCS by surveys and by monitoring their academic performance in-class assignments. Factors like race, work, involvement in professional opportunities, class standing, and goals after graduating were considered while analyzing the data.

The results of this study showed that both faculty mentoring combined with academic coaching and peer mentoring combined with academic coaching have increased the confidence

of Biomedical Engineering FGCSs significantly. FGCSs belongingness was not significantly changed after the mentoring program. Disseminating the study outcomes will provide guidelines to the Department of Biomedical Engineering and the College of Engineering at the University of Arkansas as well as the public. The effective strategies defined in the current work will be implemented towards maximizing the chances of first-generation college students' success.

## **1. Introduction**

First-Generation College Students (FGCSs) are identified as students that neither of their parents attained a college degree. First-Generation College Students comprise roughly 25% of the University of Arkansas student body and 17% of the University of Arkansas Biomedical Engineering undergraduates (5, 7). First-Generation College Students often face many challenges in college including the lack of parental guidance, economic and social burdens, isolation, decreased belongingness, and lowered self-confidence (6, 8). In addition, being in a multidisciplinary STEM field such as Biomedical Engineering is another challenge as it requires integration of different disciplines (9). Due to the numerous challenges facing them, FGCSs are at approximately 8 times more the risk of dropping out of college compared to their colleagues whose parents have attained a college degree (10). This study aims to identify efficient methods to optimize FGCSs' success in multidisciplinary STEM fields; academically and professionally. In this study, we hypothesize that faculty mentoring and peer mentoring will significantly increase FGCSs' academic and professional success. We also hypothesize that faculty mentoring peer mentoring will increase FGCSs' confidence and belongingness to the engineering community.

### **1.1. Challenges facing FGCSs**

#### **1.1.a. Parental guidance**

Students transitioning from high school into college are often faced with myriad of challenges including adjusting to new learning methodologies, time management and meeting higher expectations. Often, parental guidance helps freshmen students navigate those challenges. However, first-generation college students are a subpopulation that is more likely to be at a disadvantage when it comes to receiving parental guidance on how to navigate college. A study done by Cataldi et al. has shown that parents holding a college degree can be a significant source

of information for their children who are attending college (11). For instance, they can help their children navigate writing papers and performing research (6, 11). Contrary to this, parents who did not obtain a college degree do not usually provide the same guidance for their children, leaving them at a rougher launch at the beginning of their college education (6, 11).

### **1.1.b. Financial and social challenges**

FGCSs do not only face problems adjusting to academic life, they often are more likely to be subjected to financial difficulties. Parents of FGCSs not attaining college education leads to them usually having lower income compared to others who attained college education (6). This leaves FGCSs at a financial disadvantage compared to their peers whose parents have attained a college degree. To be able to afford college, FGCSs often work, which reduces the time they spend focusing on succeeding in college (6). A study by Hui et al. found that FGCSs needed to work at least 20 hours per week due to their economic background (6). The time FGCSs spend working which, according to Hui et al., reached 60 hours per week for some students, leads to FGCSs being less involved on campus and less integrated into the university community (6). In this study, we are investigating the work habits of FGCSs. We are also investigating the effect of working on FGCSs' academic performance.

Besides financial challenges, FGCSs are also challenged by social capital as many of them are members of minority and underrepresented groups. Students who combine being an FGCSs and belonging to a minority group often feel marginalized in the college community (6). Additionally, factors like gender, age, and residency status (being in-state versus out of state student) significantly affect the success of FGCSs to graduate college on track (6). In this study, we investigate the correlation between belonging to a racial minority and succeeding academically for FGCSs.

### **1.1.c. Belongingness and self-confidence**

In addition to the financial hardships and lack of parental guidance, FGCSs are also susceptible to having internal beliefs about themselves that can hinder their success and integration into the university community (12). These internal beliefs include their sense of belongingness, self-confidence, personal agency, efficacy, and mindset. Blue et al. found that students who came from lower economic backgrounds showed less confidence in their academic

abilities and intelligence which lead to them being less successful (12). In addition to confidence, multiple studies have identified the sense of belonging as an essential key to academic success (12-14). In this study, we investigate the impact of peer mentoring and faculty mentoring when combined with academic coaching on students' belongingness and self-confidence.

#### **1.1.d. Biomedical Engineering as a challenging multidisciplinary STEM field**

Retention of students in STEM fields and ensuring their success is critical to keeping up with the need for students in multidisciplinary STEM fields (4). Biomedical Engineering is one of the challenging multidisciplinary STEM fields as it requires the integration of medicine, biology, pharmacy, electrical engineering, mechanical engineering and material engineering (9, 15, 16). As a result, Biomedical Engineering requires a broad knowledge and a good understanding of the methodological backgrounds of each of the disciplines (9, 15). This demand for having a broad knowledge in multiple fields and the need to understand and apply the different methodological backgrounds of each field, makes Biomedical Engineering a challenging engineering discipline (9). Considering the current literature, there is currently a gap in knowledge about the challenges facing FGCSs in multidisciplinary STEM fields such as Biomedical Engineering. In this study, we are investigating the challenges facing FGCSs in Biomedical Engineering qualitatively and quantitatively and utilizing a mentoring program to optimize their academic and professional success.

#### **1.2. Mentoring**

Multiple studies have confirmed that faculty mentoring plays an important role in the success of undergraduate and graduate students in STEM fields, especially students who belong to underrepresented minorities. Faculty support can take numerous forms including supporting students' progression towards opportunities in STEM fields, providing exposure to experiences that help the students advance towards their goals, and including the students in different research opportunities (17-19). Provided that FGCSs don't often come from backgrounds that can provide them with the social networks and resources, faculty mentoring can be essential to provide FGCSs with access to the resources and opportunities (20).

Another form of mentoring besides faculty mentoring is peer mentoring. Peer mentoring has been an effective way to help students succeed academically. Peer mentoring helps students

overcome academic, social and psychological challenges that face them (21, 22). Moreover, peer mentoring was found to improve the retention of students that belong to minority groups in STEM fields (21, 23). This study aims towards identifying the challenges that face FGCSs in the field of Biomedical Engineering and employing peer-mentoring or faculty-mentoring combined with academic coaching to tackle the challenges that FGCSs face and to increase their academic and professional success. We hypothesize that both peer-mentoring and faculty-mentoring will significantly increase FGCSs' belongingness and self-confidence.

To sum up, this study aims to optimize the academic and professional success of FGCSs in multidisciplinary STEM fields such as Biomedical Engineering. The focus of this study is identifying the challenges facing FGCSs in multidisciplinary STEM fields which add to the challenges facing FGCSs such as lack of parental guidance, economic, and social challenges. First, the challenges facing FGCSs are investigated through the analysis of qualitative and quantitative data collected from FGCSs in Biomedical Engineering. To tackle these challenges, faculty mentoring, peer mentoring, and academic coaching are utilized to enhance FGCSs academic performance, self-confidence, belongingness, and professional development. FGCSs academic performance, confidence, belongingness, and involvement in professional and extracurricular opportunities are compared before and after the mentoring program to identify the impact of the mentoring program on FGCSs' academic and professional progress.

## **2. Methods**

This study aims to assess and enhance FGCSs' success on academic and professional levels. Before conducting the study, we filed for the Institutional Review Board (IRB) approval to conduct the study on student participants. After the IRB permission was obtained (Protocol #1912237719), FGCSs who were enrolled in either Biomechanical Engineering (BMEG 2813) or Biomolecular Engineering (BMEG 3824) in the Spring 2020 semester were invited to participate in the study. Nineteen students, 9 enrolled in Biomechanical Engineering and 10 enrolled in Biomolecular Engineering, signed the consent form, which was included as the first step in the pre-mentoring survey, and agreed to participate in the study. A copy of the consent form is included in appendix I.

Pre-mentoring and post-mentoring surveys were administered to assess Participants' belongingness and confidence, and to collect other data such as participants' demographics and

the challenges that face them as a result of being FGCSs. After the pre-mentoring survey was completed by the study participants, the students were assigned to either one of the following two groups; faculty mentoring combined with academic coaching or peer mentoring combined with academic coaching. Once the participants completed their mentoring and academic coaching meetings, they were asked to complete the post-mentoring survey. The post-mentoring survey included question sets to measure participants' belongingness and confidence along with questions to collect their feedback on how the mentoring and academic coaching has helped them, and the aspects that could be improved to make the mentoring and academic coaching more efficient in the future. Additionally, participants' academic performance in the Biomechanical Engineering and Biomolecular Engineering classes was examined before and after the mentoring as a means to evaluate how mentoring has impacted participants' academic performance.

### **2.1. Pre-mentoring survey**

The pre-mentoring survey was administered to all the study participants online through Qualtrics. The pre-mentoring survey was used to collect students' demographics such as gender, race, first language, etc. Additionally, the survey was used to collect data about students' awareness of campus resources such as the Wellness Center and Counseling and Psychological Services (CAPS). Furthermore, the survey collected participants' self-reported GPA, involvement on campus, workload, and career goals. Two questionnaires, that were adapted from previous studies (Blue et al. and Hartman et al.), were included in the pre-mentoring survey to assess students' confidence and belongingness before the mentoring to compare it to their confidence and belongingness after the mentoring and academic coaching (8, 12).

The belongingness questionnaire was obtained from a study conducted by Blue et al. Blue et al., adapted and combined the questions from Walton et al., and Goodenow et al., and assessed its consistency of measuring belongingness by administering it in two surveys; one survey was administered to 135 participants and the other survey was administered to 86 participant ( $\alpha(132) = .93$ ,  $\alpha(86) = .94$ ) (12). The major was changed to "Biomedical Engineering" throughout the questionnaire as Blue et al. administered it to a different engineering discipline. The belongingness questionnaire is comprised of 23 items and the students were prompted to select an answer to each question from a 7-point Likert scale. The



Likert scale options were “Strongly disagree”, “Disagree”, “Somewhat disagree”, “Neither agree nor disagree”, “Somewhat agree”, “Agree”, and “Strongly agree”. A full version of the belongingness questionnaire is included in the pre-mentoring survey in appendix II.

Similarly, the confidence questionnaire was adapted from Hartman et al. (8). The questionnaire consisted of 9 items and it measured students’ confidence in themselves as engineers. Participants were prompted to select an answer to each question from a 5-point Likert scale. For the first 8 questions, the Likert scale options were “Strongly agree”, “Agree”, “Neutral”, “Disagree”, and “Strongly disagree”. The 9<sup>th</sup> question asked about participants’ feelings about how their academic abilities compared to their peers in the Biomedical Engineering Department. The Likert scale options for the 9<sup>th</sup> question were “Far below average”, “below average”, “average”, “above average”, and “far above average”. A full version of the questionnaire is included in in the pre-mentoring survey in appendix II.

## **2.2. Mentoring and academic coaching**

Study participants who completed the pre-mentoring survey were divided into two groups: faculty mentoring and academic coaching (9 participants) or Peer mentoring and academic coaching (10 participants). Participants in the faculty mentoring and academic coaching attended three meetings (15 minutes each) with a faculty mentor and one meeting (30 – 45 minutes) with an academic coach. Similarly, participants in the peer mentoring and academic coaching attended three meetings (15 minutes each) with a peer mentor and one meeting (30 – 45 minutes) with an academic coach. The faculty mentor for this study was Dr. Mostafa Elsaadany. The peer mentors were the teaching assistants for the Biomechanical Engineering and Biomolecular Engineering classes. The academic coach was Rachel Piontak, the academic coach of the College of Engineering at the University of Arkansas.

## **2.3. Mentoring plan**

The mentoring plan was developed to be used as a guide for mentors throughout this study. The objectives of the mentoring included increasing students’: self-confidence, belongingness to the biomedical engineering community, awareness of the communal goals that can be achieved through STEM majors, academic success, awareness of their learning styles, professional success, and personal success. The plan covered academic success, professional

success, and personal success. To improve participants' academic performance, mentors guided the students on how to use the metacognition theory to improve their deep learning. Multiple studies found that the application of the metacognition theory was found to improve students' confidence by increasing their motivation and bettering their study habits (17, 18). *Honey and Mumford's (1992) Learning Style Questionnaire* was advised as a free resource for the students to find their learning styles. *College, Career, and Lifelong Success* website by Dr. Marsha Fralick was advised to the students to find efficient learning techniques that are suitable for their learning styles. As for professional development, mentors guided the students on how important pursuing internships, co-ops, and other professional opportunities are towards reaching their career goals. The resources from the University of Arkansas Career Development Center were used to provide sample resumes and cover letters for the participants.

One of the factors that decrease the retention of FGCSs in STEM fields, is the belief that STEM career tracks are not prosocial goals-oriented. Allen et al. found that one way to increase FGCSs' retention in the STEM field is through using mentorship programs to guide the students and show them that having a STEM career can fulfill communal goals (19). Mentors discussed with the students how STEM careers can have diverse career options including careers that are focused on prosocial goals.

Besides academic and professional success, being integrated into the university community is key to academic success. Often students from low economic backgrounds find it harder to integrate into the university community (8). Mentors encouraged the participants to get involved on campus in various opportunities to expand their networks and gain soft skills. Moreover, mentors also encouraged the students to use the campus resources like the Counseling and Psychological Services (CAPS) and the Wellness Center.

#### **2.4. Post-mentoring survey**

The post-mentoring survey was administered online through Qualtrics to the study participants who completed the mentoring and academic coaching meetings. The survey included the same belongingness and confidence questionnaires as the ones included in the pre-mentoring survey, to compare participants' confidence and belongingness after the mentoring to participants' confidence and belongingness before the mentoring. Also, the post-mentoring

survey was used to collect students' feedback on the mentoring and academic coaching for future improvements.

## **2.5. Data collection**

Data was collected and analyzed following the IRB (protocol #1912237719) instructions to ensure the confidentiality and security of participants' data. All data was saved securely on Box and only the principal investigator and faculty advisor of this study had access to the data. All the study participants signed the informed consent electronically before filling the pre-mentoring survey. The informed consent informed the participants about the requirements, risks, and benefits of the study. For the pre-mentoring and post-mentoring surveys, data was collected through Qualtrics software and exported to Microsoft Excel software. For the participants' performance in the Biomolecular Engineering and Biomechanical Engineering classes, participants' data was exported from the learning management system (LMS: Blackboard) to Microsoft Excel software. Microsoft Excel software was used to perform statistical analysis.

## **2.6. Data analysis**

### **2.6.a. Participants' demographic information**

Data was extracted from the pre-mentoring survey and general information about the study participants' demographic information. Breakdown of participants' information like race, gender, nationality, first language, and family education were investigated. For example, the percentages of participants' who belong to different racial groups were calculated. This data was used to gain insights about the FGCSs in the Biomedical Engineering Department at the University of Arkansas. Moreover, this data was used to gain insights into the possible factors that could be affecting FGCSs inclusion and integration into the engineering community.

### **2.6.b. Academic performance**

Information about participants' academic standing and involvement on-campus was collected through the pre and post mentoring surveys. Average self-reported Grade Point Average (GPA) and average work hours were calculated. The academic performance of the study participants was evaluated based on their GPA and their grades in the Biomolecular Engineering or the Biomechanical Engineering classes. Although GPA and grades in classes are not the single

inclusive measure of students' academic performance, both are still very good indicators of academic performance. Correlation between participants' GPA and work hours was tested using a two-sample t-test. To test the efficiency of the mentoring program and academic coaching, students' grades in the Biomolecular Engineering or Biomechanical Engineering before the mentoring were compared to their grades after the mentoring program using paired t-tests.

### **2.6.c. Belongingness and confidence**

Likert Scale questionnaires were used to assess study participants' Belongingness and Confidence. The Likert scale was converted into corresponding numerical values and paired t-tests were conducted on each question to compare the participants' confidence and belongingness Pre-mentoring to Post-mentoring. The confidence and belongingness of participants who attended faculty mentoring and academic coaching or peer mentoring and academic coaching was also tested prior to and post the mentoring program using two-sample t-tests.

### **2.6.d. Professional performance**

The professional performance of the study participants was evaluated based on their involvement in professional opportunities such as undergraduate research, internships, and co-ops. Moreover, participants' involvement in different extracurriculars and leadership opportunities on campus was surveyed. Participants' involvement in professional and extracurricular opportunities before the mentoring program was compared to their involvement in professional and extracurricular activities post the mentoring program.

### **2.6.e. Reporting data**

The sample size for the study is 19 FGCSs participants (n=19). All data was collected for the 19 participants except the testing of the belongingness and confidence questionnaires as they were reported by only 17 participants. The mean of the data is reported as M followed by  $\pm$  standard deviation. The median of the data is reported as Mdn, and the first quartile and third quartile of the data are reported as Q1 and Q3 respectively. In the graphs, \* refers to  $p < 0.05$  and \*\* refers to  $p < 0.01$ .

### 3. Results

#### 3.1. Participants' demographic information

Information about participants' race, gender, nationality, first language, and family members' education were organized in Table 1. This demographic information gives insights about participants' different identities, and some of these identities such as race are tested in this study for correlation to academic performance. As shown in Table 1, 68% of the participants belonged to minority racial groups and 58% of the participants did not report English as their first language. In section 3.6.c we are investigating how holding minority identity besides being an FGCS impacts students' academic performance.

**Table 1.** Breakdown of the demographic information of the study participants.

Category of classification	Classification of students	Number of students	Percentage of students
<b>Total number of students</b>		19	
	Students enrolled in Biomolecular Engineering	10	53%
	Students enrolled in Biomechanical Engineering	9	47%
<b>Race</b>			
	White	6	32%
	Black or African American	3	16%
	Hispanic or Latino	9	47%
	Asian	1	5%
<b>Nationality</b>			
	Domestic	13	68%
	International	6	32%
<b>First Language</b>			
	English	8	42%
	Another language	11	58%
<b>Gender</b>			
	Male	6	32%
	Female	13	68%
	Other	0	0%
<b>Family members' education</b>			
	Having siblings who obtained a college degree	6	32%
	Not having siblings who obtained a college degree	13	68%

### 3.2. Challenges facing FGCSs

Study participants were asked about the challenges that are facing them as FGCSs through the pre-mentoring survey. Table 2 shows the responses of the participants to an open response question about the challenges facing them as FGCSs. The most reoccurring challenge that students reported was the lack of parental guidance on how to navigate college and plan for a career. Other challenges reported by the students included holding minority identities such as being a female in STEM field or coming from a different culture and having financial challenges.

**Table 2.** Challenges facing FGCSs

<b>Participants open response to the challenges facing them as FGCSs</b>
“Transitioning”
“I feel that others--regardless of identifying at FGCS or not--do not understand where I come from. In my culture, it is expected for females to not attend college. So coming to college makes me feel like I am breaking my tradition. And as a first generation American, I can only embrace so much of a culture in America. Meaning, breaking my tradition breaks the only ties I have with Laos. Yet, a lot of people in America expect me to go to college anyway because I am Asian. I feel that the biggest challenge I face as a FGCS is people not understanding how lost I am, and how I try to fit in on the expectations of an Asian in America, and the Lao woman I am supposed to be in the Lao community.”
“My parents never finished college, so they cannot really give me advice in case I need it. I have a full-ride scholarship that pays my college education otherwise, my parents would never be able to pay this university. There are some things that are not so important but still useful such as a car that my scholarship does not cover and that my parents cannot afford.”
“I didn't face major challenges since my all older siblings had graduated from college before me.”
“Starting college and deciding a degree without any guidance was hard. I didn't have any help in regards any of my choices towards my academics and even now I don't. I have to literally do my own research and find the appropriate help whenever I have a question or need help because I know my parents are not able to help me.”

“Didn’t know how to navigate college, how to ask for help without feeling like I’m not smart, imposter syndrome, how to prioritize certain college aspects”

“During my college application process my parents weren't able to give me any advice for completing my application. I had to learn everything by myself and communicate everything I learned to them.”

“One challenge would be to not have someone with experience to help me choose my career path.”

“I guess not having any kind of guidance in what I'm doing. I definitely can't ask my parents for help because they don't know what's required of me.”

“I think one of the big things is trying to find your way initially, especially in engineering where it is advantageous to get involved in things as early as possible.”

“My parents cannot offer guidance as most other parents can.”

“Be an example for my sister.

Don’t fail my classes.

Get good grades to keep the necessary GPA for my scholarship.”

“There is no one in my family that can relate or know how I feel”

“- The tuition cost.

- Lack of guidance on how to get the most out of college.”

“The main challenge I face is that when I am faced with difficult academic issues, I can't simply call one of my parents and ask for advice. Although they will always help me to the best of their ability, they have no college background to use as a reference for their advice. Basically, it sometimes feels like I am on my own, not literally, but in terms of making certain decisions that seem difficult or very complex in nature.”

“I couldn’t/ can’t rely on my parents for advice for what I can do to prepare me for post-grad. For instance: what I can do to ensure my success when it comes to grad school, how to go about making connections for the future, etc. Fortunately, my sister (2 years older in grad school here) is able to push me in that regard, but for obvious reasons it is different.”

“As a first-generation college student. I sometimes feel a lot of pressure to make it well and make my family proud of what I am doing. Also, I want to be able to do it well in my classes and be a competent worker in the future.”

### 3.3. Academic success

#### 3.3.a. Surveying participants academic information

Participants' academic information such as class standing, Honors status, and having a faculty mentor were organized in Table 3. Factors that could be affecting participants' academic performance such as workload and being a Path program member (Path program is a program that helps FGCS at s the University of Arkansas) were also organized in Table 3. More information about workload and academic load was further investigated in section 3.3.b.

**Table 2.** Breakdown of the academic information of study participants.

Category of classification	Classification of students	Number of students	Percentage of students
<b>Class Standing</b>			
	Senior	8	42%
	Junior	2	11%
	Sophomore	8	42%
	Other	1	5%
<b>Honors College</b>			
	Honors Students	5	26%
	Regular Students	14	74%
<b>Path Program</b>			
	Path Participants	1	5%
	Not Path Participants	18	95%
<b>Work</b>			
	Working	10	53%
	Not working	9	47%
<b>Faculty mentoring <sup>^</sup></b>			
	Having Faculty mentor who helps and guide them	3	16%
	Not having faculty mentor	14	74%
	other	2	11%

<sup>^</sup> Faculty mentoring refers to a faculty member that students usually consult with and discuss their plans or the challenges they are facing with.



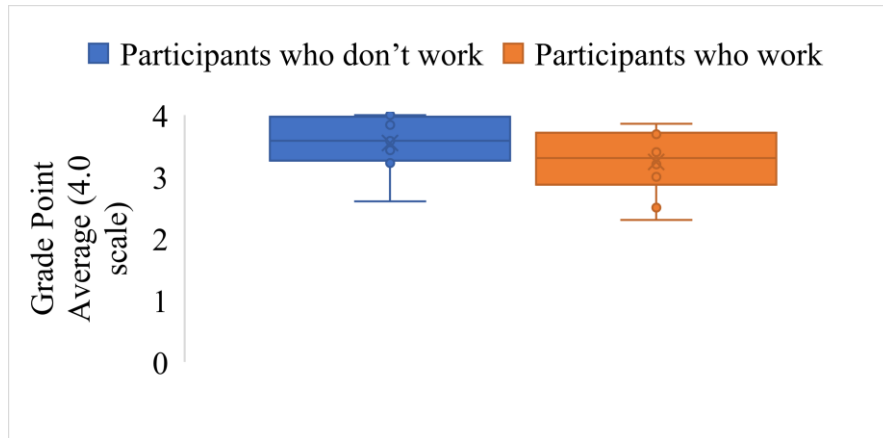
### 3.3.b. Impact of work on FGCSs' academic performance

The academic success of participants was assessed based on their GPA and their grades in the Biomechanical Engineering or Biomolecular Engineering classes. First, the impact of work hours on participants' GPA was investigated. As shown in Table 3, 10 (53%) of the 19 study participants worked. The average work hours for those working participants were 19.5 hours per week ( $M=19.5 \pm 7.7$ ) as reported in Table 4. Hui et al. showed that the average work hours of FGCSs is 20 hours per week (6). Hui et al. found that the work hours limited the amount of time that FGCSs can spend focusing on their academic work (6). In this study, we are looking to identify the factors that are limiting the success of FGCSs. As a result, we investigated the correlation between the work hours and the GPA of participants. Figure 1 shows the GPA distribution of participants who work and those who do not work. The mean GPA of the students who worked ( $M=3.24 \pm 0.51$ ) was lower than the mean GPA of those who do not work ( $M=3.54 \pm 0.44$ ); however, the difference was not significant ( $p = 0.20$ ).

**Table 4.** Course load and workload of study participants

Classification category	Classification	Average	Standard deviation
<b>Number of credit hours taken</b>			
	All students	15.4	3.1
	Biomolecular Engineering	14.5	3.7
	Biomechanical Engineering	16.6	1.7
<b>Average GPA</b>			
	All students	3.4	0.5
	Biomolecular Engineering	3.1	0.4
	Biomechanical Engineering	3.7	0.4
<b>Work<sup>^</sup></b>			
	Average work hours per week	19.5	7.7

<sup>^</sup>Average work hours were calculated based on the students who work which are 53% of the study participants.

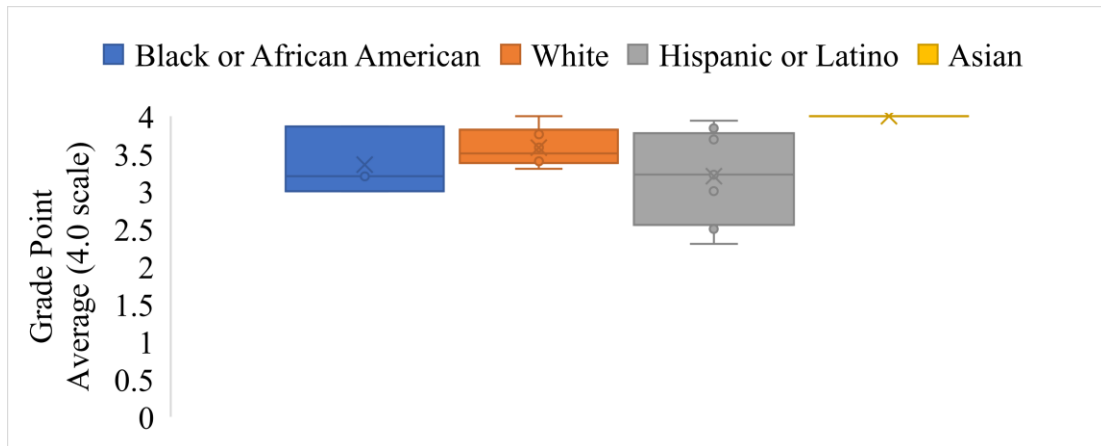


**Figure 1. Box plot of the GPA data of students who work and those who do not work.**

The median, first quartile, and third quartile of the GPA of participants who work (Mdn=3.30, Q1=2.99, Q3=3.69) are lower than the median, first quartile, and third quartile of the GPA of those who do not work (Mdn=3.58, Q1=3.30, Q3=3.94). Overall, the GPA of students who work was not significantly lower than the GPA of students who do not work ( $p=0.20$ ).

### 3.3.c. Impact of holding a minority identity on academic performance of FGCSs

One of the factors that add to the challenges facing FGCSs is holding a minority identity besides being FGCSs (6). Hui et al. reported that often holding a minority identity leads to the students feeling marginalized (6). In our study, we investigate whether belonging to a racial minority group besides being an FGCS affects students' academic performance. Investigating whether belonging to minority identity or not was crucial for this study as 68% of the FGCSs who participated in this study belonged to a racial minority group. Students' GPA was examined among the different racial groups that the students reported they belong to. Figure 2 shows the distribution of the GPA of the different racial groups. Participants who belonged to White, Black or African American, and Hispanic or Latino racial groups had the following means of GPA respectively ( $n=6$ ,  $M= 3.57\pm0.24$ ;  $n=3$ ,  $M=3.35\pm0.37$ ;  $n=11$ ,  $M= 3.19\pm0.59$ ).

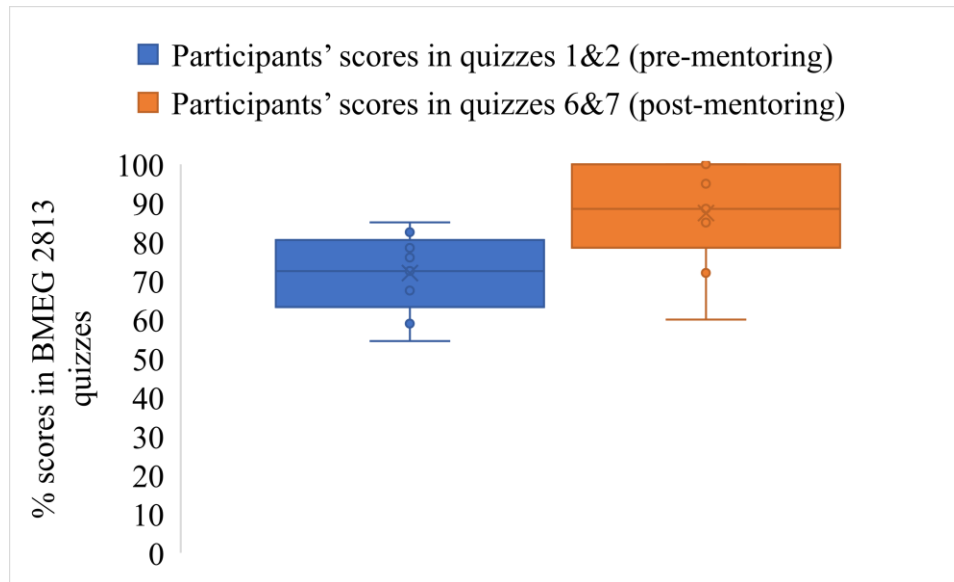


**Figure 2. Box plot of the GPA of FGCSs based on racial identities.**

Participants who belonged to Black or African American, White, and Hispanic or Latino racial groups had the following medians of GPA respectively (Mdn=3.20; Mdn=3.50; Mdn=3.22).

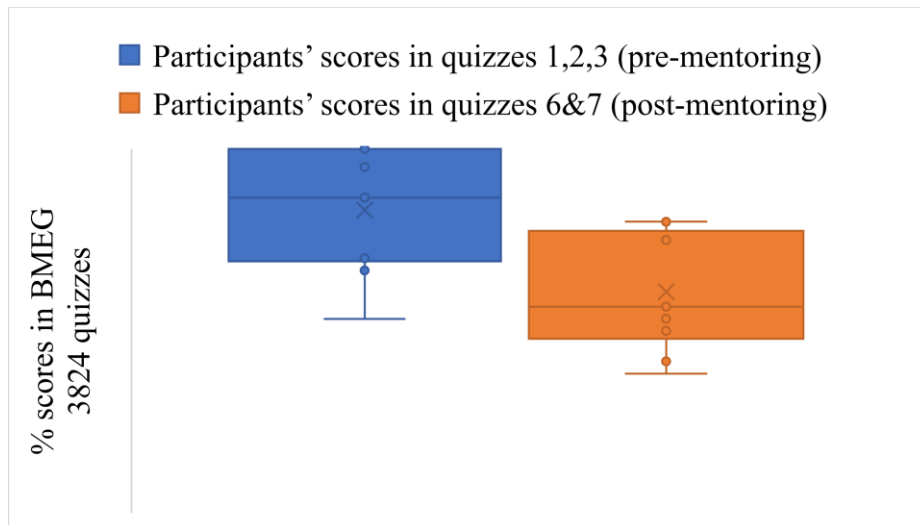
### 3.3.d. Impact of mentoring program on academic performance of FGCSs in Biomechanical Engineering and Biomolecular Engineering classes

After assessing some of the challenges that are facing FGCSs and hindering their academic success, the impact of mentoring on their academic performance was assessed. As this study aims at using mentoring to improve student's academic performance, students' grades in the quizzes of the Biomechanical Engineering and Biomolecular Engineering classes were investigated. For the Biomechanical Engineering class, quizzes 1 and 2 were assigned before the mentoring program, and quizzes 6 and 7 were assigned after the mentoring program. Figure 3 shows the distribution of the grades of quizzes 1 and 2 and quizzes 6 and 7 for the participants enrolled in the Biomechanical Engineering class. Students' mean scores in quizzes 1 and 2 ( $M=72.00\pm 9.62$ ) were significantly lower than the mean of their scores in quizzes 6 and 7 ( $M=87.39\pm 13.04$ ;  $p=0.007$ ). For the Biomolecular Engineering class, quizzes 1, 2, and 3 were assigned before the mentoring program and quizzes 6 and 7 were assigned after the mentoring program. Quizzes 6 and 7 were both assigned online due to the switch of the of the University of Arkansas classes to online learning as a response to the COVID-19 situation. Figure 4 shows the distribution of the grades of the study participants in quizzes 1,2, and 3 and quizzes 6 and 7. Students' mean scores in quizzes 1, 2, and 3 ( $M=83.17\pm 15.51$ ) were significantly higher than the mean of their scores in quizzes 6 and 7 ( $M=60.83\pm 14.36$ ,  $p=0.0001$ ).



**Figure3. Box plot of the averages of the participants' scores in Biomechanical Engineering (BMEG 2813) quizzes before and after the mentoring program.**

The median, first quartile, and third quartile of quizzes 1 and 2 (Mdn=72.50, Q1=67.50, Q3=78.50) are lower than the median, first quartile, and third quartile of quizzes 6 and 7 (Mdn=88.50, Q1=85.00, Q3=100). Overall, the participants' grades in quizzes 6 and 7 were significantly higher than their grades in quizzes 1 and 2 ( $p=0.007$ ).



**Figure 4. Box plot of the averages of the participants' scores in Biomolecular Engineering (BMEG 3824) quizzes before and after the mentoring program.**

The median, first quartile, and third quartile of quizzes 1,2, and 3 (Mdn=86.67, Q1=70.00, Q3=98.75) are higher than the median, first quartile, and third quartile of quizzes 6 and 7 (Mdn=56.67, Q1=50.83, Q3=76.25). Overall, the participants' grades in quizzes 6 and 7 were significantly lower than their grades in quizzes 1, 2 and 3 ( $p=0.0001$ ).

### 3.3.e. Impact of mentoring program on confidence of FGCSs

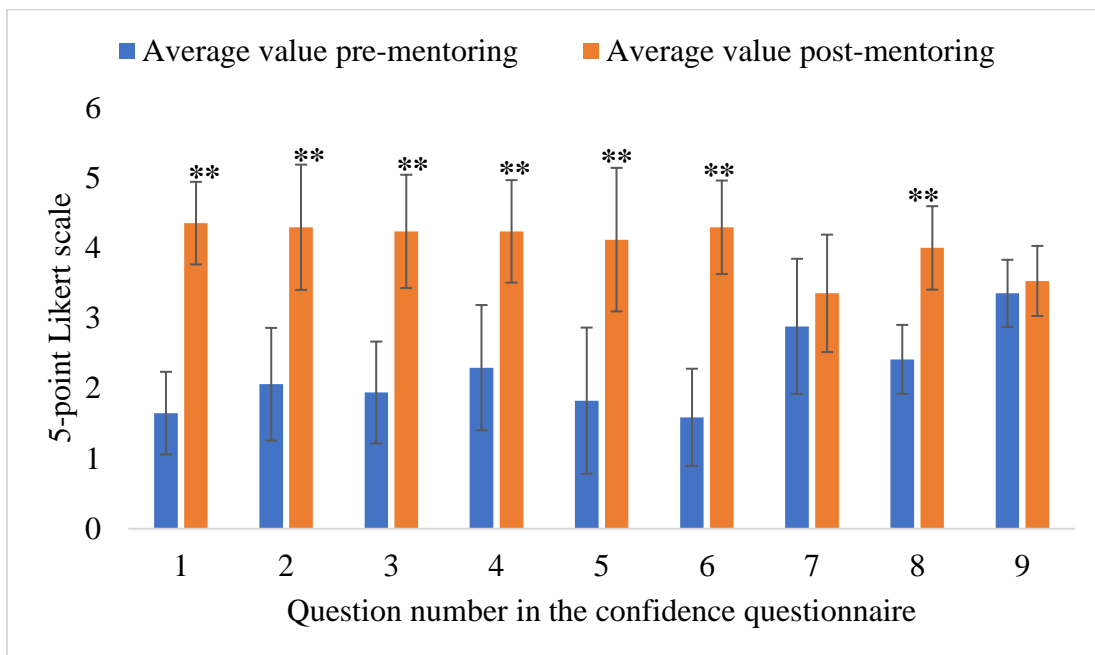
One of the challenges facing FGCSs is having internal beliefs about themselves that lead to hindering their academic performance and integration into their university's community (12). In this study, we investigated the effect of mentoring program on the confidence of the study participants. A confidence questionnaire comprised of 9 questions was administered to the participants who were prompted to answer the questions on a 5-point Likert scale. The 5-point Likert scale options for questions 1-8 were: "Strongly agree", "Agree", "Neutral", "Disagree", and "Strongly disagree" and the corresponding numeric values were 1 -5 respectively. For example, "Strongly agree" corresponded to 5 and "Strongly disagree" corresponded to 1. The Likert scale options for the 9<sup>th</sup> question were "Far below average", "Below average", "Average", "Above average", and "Far above average" and the corresponding numeric values were 1 -5 respectively. Table 5 shows the 9 items of the confidence questionnaire. The average of the participants' scores for each question was calculated before and after the mentoring program. In Figure 6, the average value for each question is reported before and after the mentoring program. Questions 1, 2, 3, 4, 5, 6, and 8 showed a significant difference before mentoring with respect to after mentoring ( $p < 0.05$ ). Questions 7 and 9 average scores were higher after the mentoring program; however, the difference was not statistically significant ( $p > 0.05$ ). Figure 7 shows the overall distributions of the average scores of the confidence questionnaire. Overall, the confidence of the students was significantly increased after the mentoring program ( $p = 0.0003$ ).

**Table 5.** Confidence questionnaire

Question number	Question statement ^
1	I am well suited for my choice of college major
2	I am confident in my overall academic ability
3	I am confident in my ability to succeed in my college engineering courses
4	I am competent in the skills required for my major
5	I am confident that someone like me can succeed in an engineering career
6	I expect that engineering will be a rewarding career

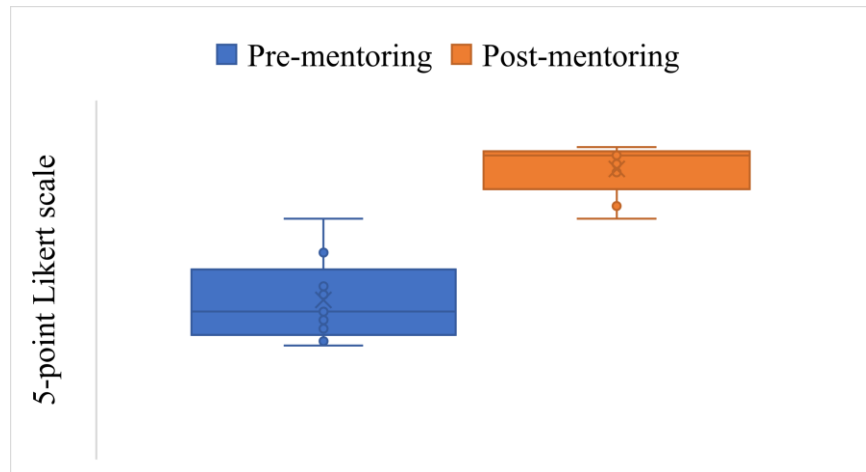
7	I will have no problem finding a job when I have obtained an engineering degree
8	My engineering coursework will prepare me for a job in engineering
9	Compared to other students in my classes, I think my academic abilities in my engineering classes

^ The questionnaire was preceded by the following prompt: “For the following statements, select the choice that describes you the most”. The options for answering questions 1-8 were: “Strongly agree”, “Agree”, “Neutral”, “Disagree”, and “Strongly disagree”. The options for answering question 9 were “Far below average”, “Below average”, “Average”, “Above average”, “Far above average”.



**Figure 6. Comparison between the average values of the individual questions of the confidence questionnaires before and after the mentoring program combined with academic coaching.**

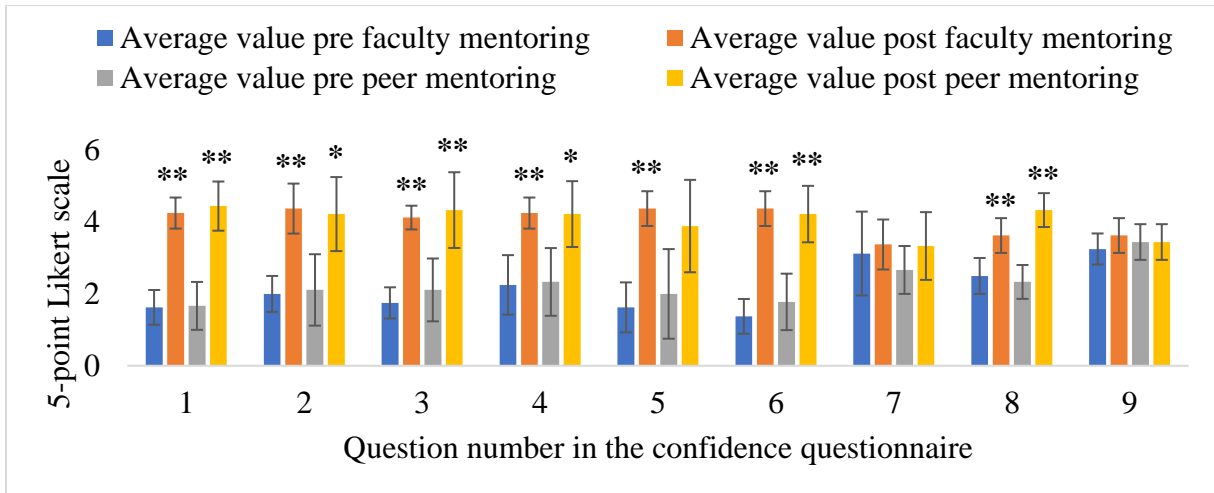
\*\* refers to  $p < 0.01$  of the scores of a post-mentoring question with respect to the scores of the same question pre-mentoring. Questions 1, 2, 3, 4, 5, 6, and 8 all showed significant difference post-mentoring with respect to pre-mentoring.



**Figure7. Box plot of the data in Figure 6. The effect of the mentoring program combined with academic coaching on participants’ confidence.**

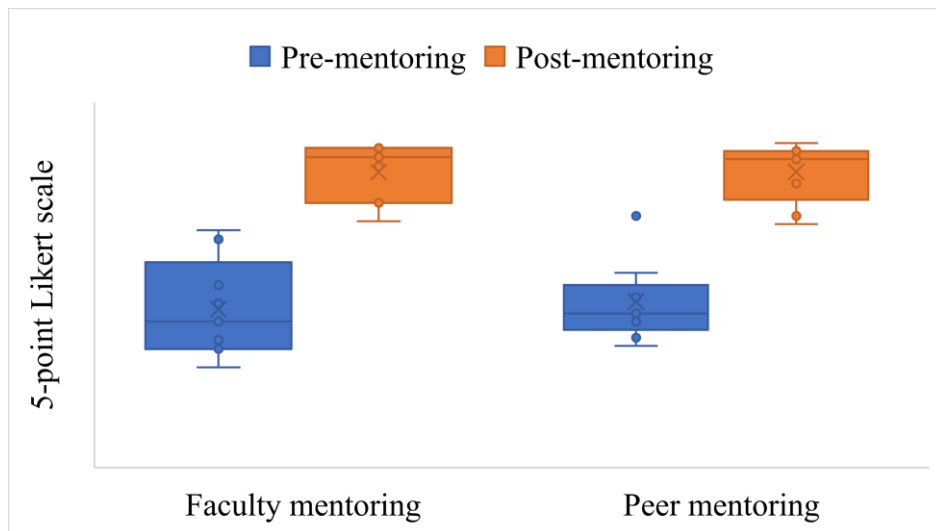
Overall, the averages of the scores of the 9 questions of the confidence questionnaire were significantly different post-mentoring with respect to pre-mentoring ( $p=0.0003$ ).

This study employs a mentorship program; faculty or peer mentoring, combined with academic coaching to optimize the success of FGCSs. The mentoring plan that both faculty and peer mentors followed was the same. As a result, we were able to compare the impact of faculty mentoring combined with academic coaching and peer mentoring combined with academic coaching on students’ confidence. Figure 8 shows the average scores of each item in the confidence questionnaire before and after the mentoring program for the two groups: faculty-mentored students and peer-mentored students. Both faculty-mentored and peer-mentored students showed a significant increase in confidence after the mentoring program with respect to the confidence before the mentoring program ( $p=0.003$ ;  $p=0.006$  for faculty and peer mentoring respectively). Figure 9 shows the distribution of the average scores of the 9 questions of the confidence questionnaires for peer mentoring and faculty mentoring before and after the mentoring program.



**Figure 8. Comparison between the average values of the individual questions of the confidence questionnaires before and after faculty mentoring combined with academic coaching and peer mentoring combined with academic coaching.**

\* refers to  $p < 0.05$  and \*\* refers to  $p < 0.01$  of the values of a post-mentoring question with respect to the values of the same question in the pre-mentoring survey. For faculty-mentored participants, questions 1, 2, 3, 4, 5, 6, and 8 all showed a significant difference in post-mentoring with respect to pre-mentoring. For peer-mentored participants, questions 1, 2, 3, 4, 6, and 8 showed significant difference post-mentoring with respect to pre-mentoring.



**Figure 9. Box plot of the data in Figure 8. The effect of Faculty mentoring and peer mentoring combined with academic coaching on participants' confidence.**

Overall, both faculty-mentored and peer-mentored students showed a significant increase in confidence after the mentoring program with respect to the confidence before the mentoring program ( $p = 0.003$ ;  $p = 0.006$  for faculty and peer mentoring respectively).



### 3.3.f. Impact of mentoring program on belongingness of FGCSs

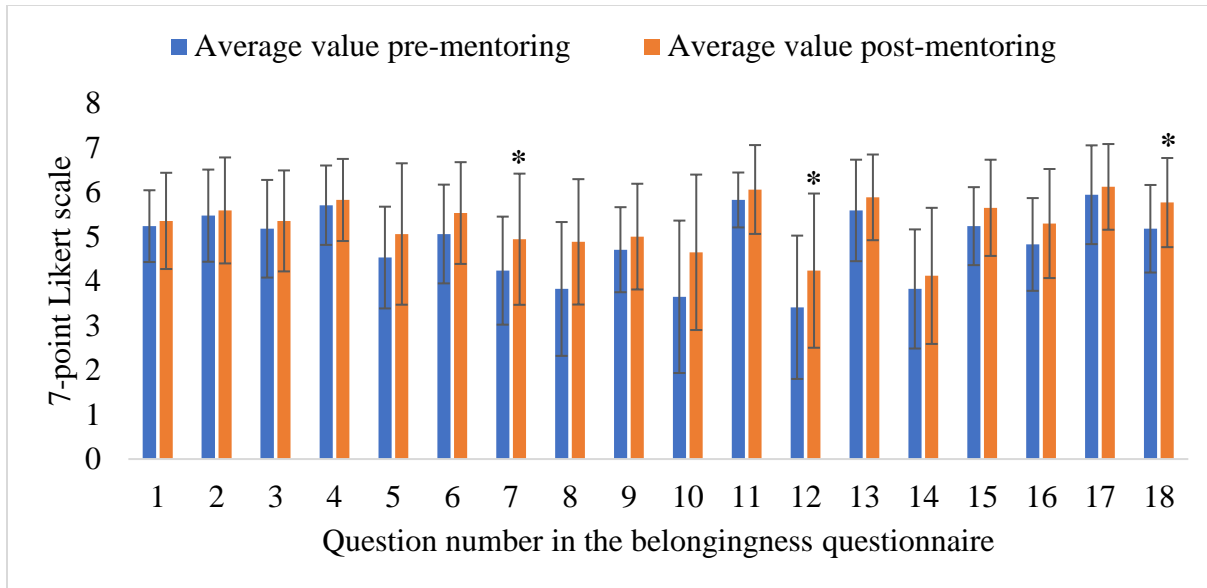
Similar to investigating the impact of the mentoring program combined with academic coaching on participants' confidence, we investigated the effect of mentoring program on the belongingness of the study participants. A belongingness questionnaire comprised of 18 questions was administered to the participants who were prompted to answer the questions on a 7-point Likert scale. The 7-point Likert scale options were: "Strongly disagree"; "Disagree"; "Somewhat disagree"; "Neither agree nor disagree"; "Somewhat agree"; "Agree"; "Strongly agree" and the corresponding numeric values were 1-7 respectively for all the questions except questions 8, 10, and 14. For example, "Strongly agree" corresponded to 7 and "Strongly disagree" corresponded to 1. For questions 8, 10, and 14, "Strongly disagree"; "Disagree"; "Somewhat disagree"; "Neither agree nor disagree"; "Somewhat agree"; "Agree"; "Strongly agree" corresponded to the numeric values 7-1 respectively. For example, "Strongly agree" corresponded to 1 and "Strongly disagree" corresponded to 7. Table 6 shows the 18 items of the belongingness questionnaire. The average of the participants' scores for each question was calculated before and after the mentoring program. In Figure 10, the average value for each question is reported before and after the mentoring program. The majority of the average scores of questions in the belongingness questionnaire showed an increase post mentoring with respect to pre mentoring; however, the difference was not statistically significant except for questions 7, 12 and 18. Figure 11 shows the overall distributions of the average scores of the belongingness questionnaire. Overall, the belongingness of the students after the mentoring program was higher with respect to before the mentoring program but the difference was not statistically significant ( $p=0.07$ ).

**Table 6.** Belongingness questionnaire

Question number	Question statement ^
1	People in the Department of Biomedical Engineering like me.
2	I feel like I belong in the Department of Biomedical Engineering.
3	I fit in well in the Department of Biomedical Engineering.
4	I feel comfortable in the Department of Biomedical Engineering.
5	People in the Department of Biomedical Engineering are a lot like me.

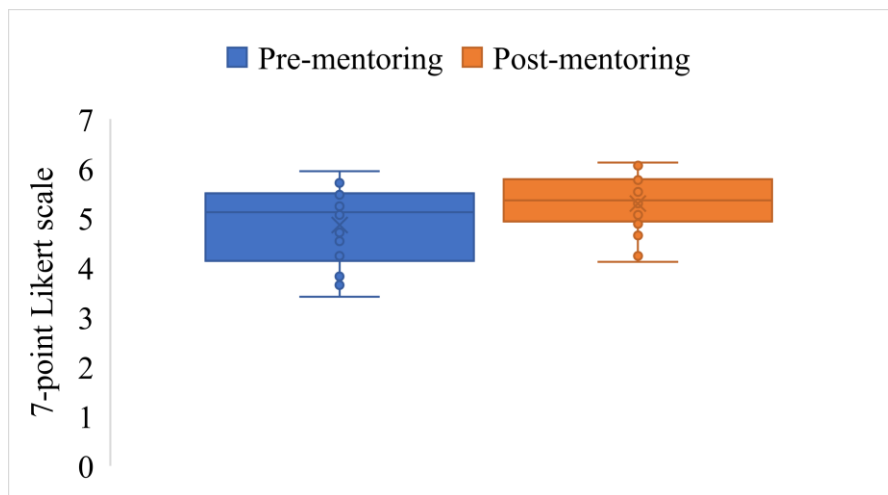
6	I feel like a real part of the Department of Biomedical Engineering.
7	People in the Department of Biomedical Engineering notice when I'm good at something.
8	It is hard for people like me to be accepted in the Department of Biomedical Engineering.
9	Other students in the Department of Biomedical Engineering take my opinions seriously.
10	Sometimes I feel as if I don't belong in the Department of Biomedical Engineering.
11	People in the Department of Biomedical Engineering are friendly to me.
12	I am included in a lot of activities in the Department Biomedical Engineering.
13	I am treated with as much respect as other students in the Department of Biomedical Engineering.
14	I feel very different from most other students in the Department of Biomedical Engineering.
15	I can really be myself in the Department of Biomedical Engineering.
16	People in the Department of Biomedical Engineering know I can do good work.
17	I feel proud of belonging to the Department of Biomedical Engineering.
18	Other students in the Department of Biomedical Engineering like me the way I am.

^ The questionnaire was preceded by the following prompt: "For the following statements, select the choice that describes you the most". The options for answering questions 1-8 were: "Strongly disagree"; "Disagree"; "Somewhat disagree"; "Neither agree nor disagree"; "Somewhat agree"; "Agree"; "Strongly agree".



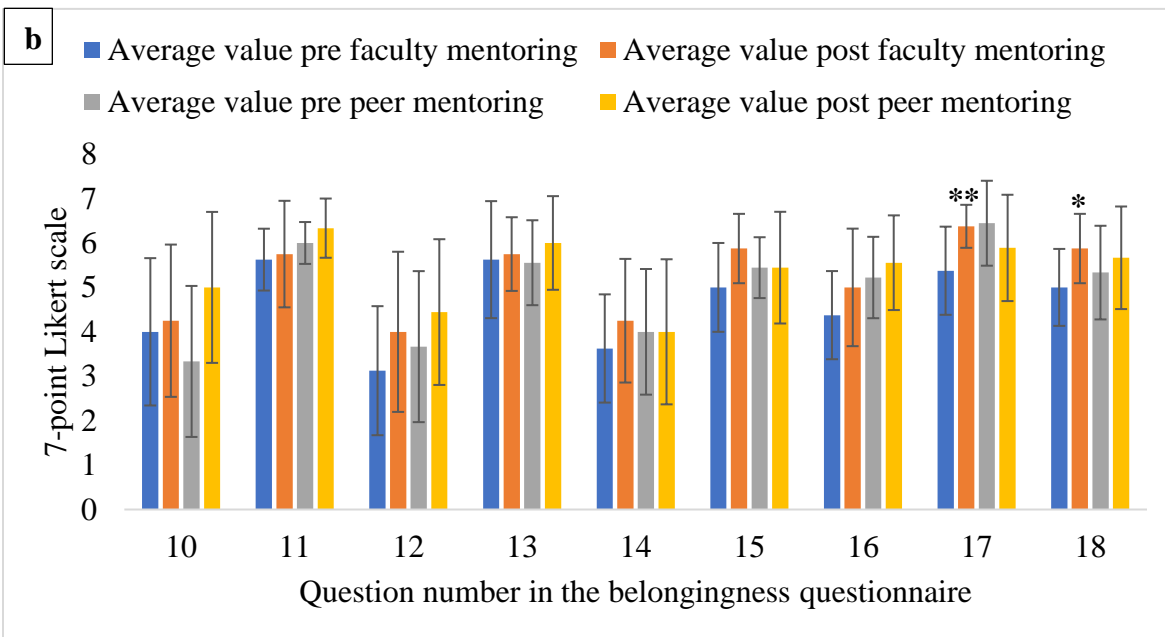
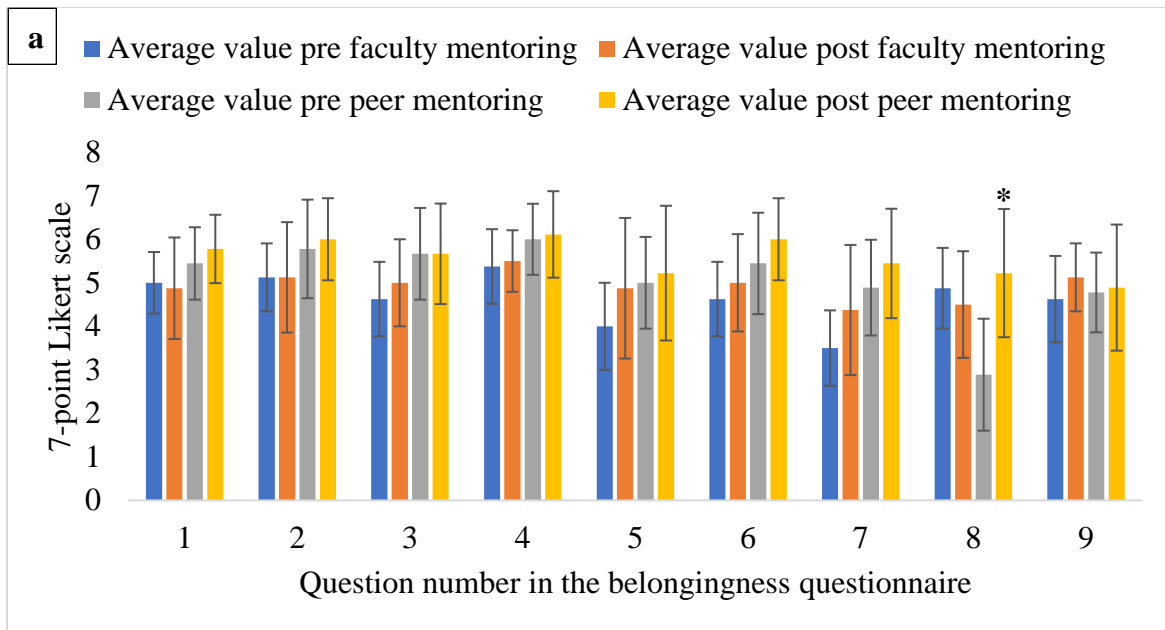
**Figure 10. Comparison between the average values of the individual questions of the belongingness questionnaires before and after the mentoring program combined with academic coaching.**

\* refers to  $p < 0.05$  of the scores of a post-mentoring question with respect to the scores of the same question pre-mentoring. Only questions 7, 12 and 18 showed significant difference post-mentoring with respect to pre-mentoring.



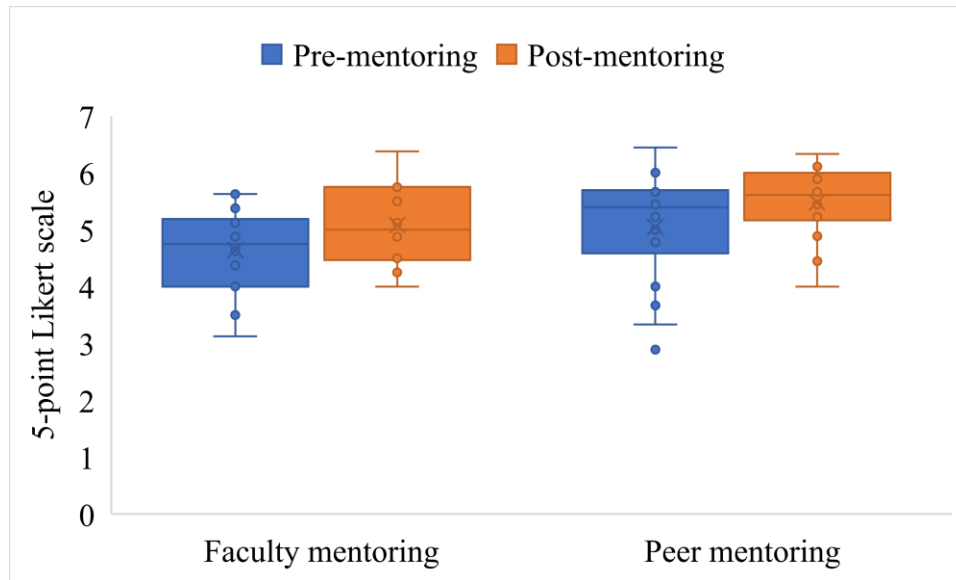
**Figure11. Box plot of the data in Figure 10. The effect of the mentoring program combined with academic coaching on participants' belongingness.**

Overall, the averages of the scores of the 18 questions of the belongingness questionnaire were higher post-mentoring with respect to pre-mentoring but the difference was not statistically significant ( $p=0.07$ ).



**Figure 12 a-b. Comparison between the average values of the individual questions of the belongingness questionnaires before and after faculty mentoring combined with academic coaching and peer mentoring combined with academic coaching.**

\* refers to  $p < .05$  and \*\* refers to  $p < 0.01$  of the values of a post-mentoring question with respect to the values of the same question in the pre-mentoring survey. For faculty-mentored participants, only questions 17 and 18 showed a significant difference in post-mentoring with respect to pre-mentoring. For peer-mentored participants, only question 8 showed significant difference post-mentoring with respect to pre-mentoring.



**Figure 13. Box plot of the data in Figure 12 a-b. The effect of Faculty mentoring and peer mentoring combined with academic coaching on participants' belongingness.**

Overall, faculty-mentored students showed promising, yet not statistically significant, increase in belongingness after the mentoring program with respect to the belongingness before the mentoring program while peer-mentored students showed no significant increase in belongingness after the mentoring program with respect to the belongingness before the mentoring program ( $p=0.07$ ;  $p=0.12$  for faculty and peer mentoring respectively)

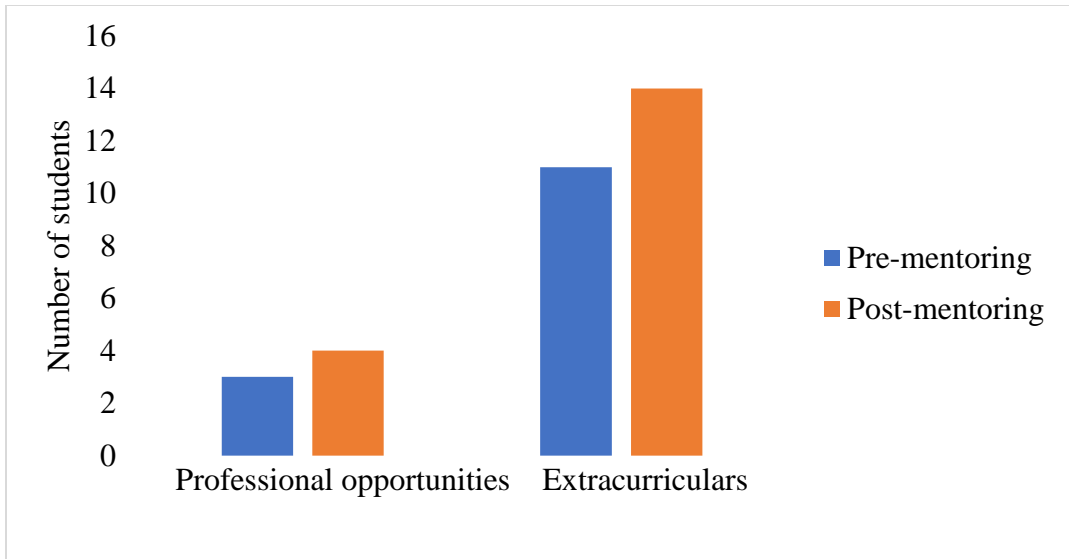
The impact of faculty mentoring combined with academic coaching and peer mentoring combined with academic coaching on students' belongingness was assessed. Figure 12 a-b shows the average scores of each item in the belongingness questionnaire before and after the mentoring program for the two groups: faculty-mentored students and peer-mentored students. Faculty-mentored students showed promising, yet not statistically significant, increase in belongingness after the mentoring program with respect to the belongingness before the mentoring program and peer-mentored students showed an increase in belongingness after the mentoring program with respect to the belongingness before the mentoring program, but it wasn't significant ( $p=0.07$ ;  $p=0.12$  for faculty and peer mentoring respectively). Figure 13 shows the distribution of the average scores of the 18 questions of the belongingness questionnaires for peer mentoring and faculty mentoring before and after the mentoring program.

### 3.3.g. Impact of mentoring program on the involvement of FGCS in professional and extracurricular opportunities

Information about participants' goals after graduation, involvement in professional and extracurricular opportunities was investigated and reported in Table 7. Regarding the career goals, 32% of the participants chose graduate school, 21% chose medical or dental school, and 26% chose industry. Participants' involvement was assessed before and after the mentoring program. Figure 14 shows the number of students who were involved in professional or extracurricular opportunities before and after the mentoring program.

**Table 7.** Study participants professional and involvement information

Category of classification	Classification of students	Number of students	Percentage of students
<b>Career Goals</b>			
	Graduate School	6	32%
	Medical School or Dental School	4	21%
	Industry	5	26%
	Other	4	21%
<b>Participation in research or internship opportunities</b>			
	Participated in research or internship opportunities	3	16%
	Did not participate in research or internship opportunities	16	84%
<b>Involvement on-campus</b>			
	Participating in leadership or extracurricular activities on campus	11	58%
	Did not participating in leadership or extracurricular activities on campus	8	42%



**Figure14. Involvement of study participants in professional and extracurricular opportunities before and after the mentoring program.**

### 3.3.h. Participants’ feedback on the mentoring program

In the post-mentoring survey, participants were prompted to provide their feedback on how the mentoring program has contributed to their academic success. Table 8 shows the participants’ responses on how the mentoring program has contributed to their success. Multiple students reported that it contributed to their studying whether it was through talking to the academic coach, reinforcing their learning styles, adjusting to online classes, or figuring out new approaches to study.

**Table 8. Mentorship program contribution to FGCSs academic performance**

Participants open response to the mentorship program contribution to their academic performance
“It helped me find someone that has an idea of what it feels to be biomed and premed. There was also someone that I can ask questions to about anything like classes and research.”
“Speaking with the Academic Coach, Rachel Piontak, really made me focus on how I will be using my time during online classes.”

“It contributed on my study options. For example, [it] is go to have more than one way of study. Also, It is important to know that we have support (coaching program) from the BMEG department. It is really good that students have [access] to [this] help. I [didn’t] have it at the beginning of my major (freshmen and sophomore year). Even though I am senior, I feel thankful that I have access to this help because I can have a better orientation on what I going to do after college.”

"I have realized/ reinforced my learning styles. I have the resources to learn how to actively find and research job opportunities and become more active in extracurricular activities."

“The mentorship helped me understand that there are resources available to me when I need them. Additionally, the mentorship program helped me realize that I am not alone and that there are others that are on the same boat.”

“It helped me to become more comfortable with my accomplishments and it gave me great advice in regards of the career. I feel that it was a great opportunity to also build a relationship and to have mentor to help me when I need guidance in the future.”

“I feel like it would have contributed more if I was not a senior.”

“Before the mentoring service, I had already made a low C on Exam 1 in Biomechanics. Right before the end of the mentoring service, I was able to make 95 on Exam 2. I feel like the service was very beneficial to me in that it allowed me to connect with another peer that had experienced some of the same things academically that I have and that was also currently experiencing similar academic challenges to me.”

“I believe that more structured mentoring program to focus more on academics as compared to resources could be more effective.”

“The mentorship program allowed me to explore new ways to study. It also helped me think about my career goals.”

“This mentorship program gave me important information (UARK resources) that I didn't know I needed to perform the best of my ability. I received professional advice on how to go about my schedule which will help me complete all my tasks efficiently.”

“It helped me get to talk to the professor and discuss my studies and my future goals”

“I gained confidence to ask for help and learn about resources regarding mental health and academic assistance.”



“Being able to talk to a mentor about developing better skills really helps.”
“It introduced me to many resources on campus that can help me in my academics and life on campus. I was given tips on how to approach professors for research opportunities which I believe will be useful.”
“It is too early to tell, but I enjoyed being introduced to available resources on campus”
“I received good advice on how to adjust to all classes online”
“I helped me to learn more about the coaching engineering program and a formal way to request participation in an internship or another Biomedical Engineering activity.”

#### 4. Discussion

FGCSs are often faced with a myriad of challenges including lack of parental guidance, economic challenges, social challenges and having internal beliefs that can hinder their academic success and retention in STEM fields (6, 8). These challenges make FGCSs at a higher risk of dropping out of STEM fields compared to others (4). Multidisciplinary STEM fields such as Biomedical Engineering require the integration of different disciplines such as medicine, pharmacy and engineering and understanding the methodological backgrounds of those different disciplines (9, 15). This multidisciplinary nature of Biomedical Engineering makes it a challenging engineering discipline (15, 16). The combined challenges of studying a multidisciplinary STEM field and being an FGCS needs to be investigated to come up with the best strategies that ensure the retention and success of FGCSs in multidisciplinary STEM fields such as Biomedical Engineering. There is currently a gap in literature about the challenges that faces FGCSs in multidisciplinary STEM fields such as Biomedical Engineering. In this study, we investigated the challenges facing FGCSs in one of the multidisciplinary STEM fields; Biomedical Engineering. Study participants were asked about the challenges facing them as FGCSs using the pre-mentoring survey. As reported in Table 2, the students expressed many challenges including the lack of parental guidance, economic challenges, and challenges navigating college. One of the study participants described the challenges facing him/her as FGCS saying, “My parents never finished college, so they cannot really give me advice in case I need it”. Another participant described the struggles when he/she entered college as an FGCS saying, “[I] Didn’t know how to navigate college, how to ask for help without feeling like I’m not smart... [or] how to prioritize certain college aspects”. Another participant also answered,

“... I have to literally do my own research and find the appropriate help whenever I have a question or need help because I know my parents are not able to help me”.

When examining the challenges reported by the students in Table 2 thoroughly, the most reoccurring theme is the lack of guidance and having a guide that can provide advice based on their experience. However, this is not always the case for all FGCSs. When a mentor figure exists, it eases the transitioning to college for FGCSs (21). One of the participants reported that “[he/she] didn't face major challenges since [his/her] all older siblings had graduated from college before [him/her].” In this case, this student's siblings were able to provide the experience to help him/her navigate the challenges that faced her as an FGCSs. However, for 68% of the participants in this study, none of their siblings attained a college degree, which could lead to them lacking guidance on how to navigate college. In order to optimize FGCSs’ success and narrow the gap between them and their Continuing College Students (CCSs) colleagues, whose either or both of their parents have attained a college degree, mentoring should be provided to FGCSs. Mentoring would be a vital way to ensure that FGCSs receive guidance and have access to resources and opportunities.

Due to the financial challenges facing them, FGCSs often need to work to be able to afford university tuition (6). The average workhours that FGCSs needed to work were found to be 20 hours per week in a study conducted over FGCSs at the University of Arkansas in 2017 (6). In our study, 53% of the participants worked and the average work hours for those who worked were 19.5 hours per week. Hui et al. reported that the time FGCSs spend working deducts from the time they can spend focusing on their academic performance (6). In this study, the GPA of working students was compared to the GPA of students who didn’t work. As shown in Figure 1, the average GPA of students who didn’t work was slightly higher, but not significantly different with respect to the GPA of students who worked.

Besides being an FGCS, belonging to a minority group in the STEM field adds to the challenges due to the underrepresentation of those groups in STEM fields (4). The results of this study show that the majority of the participants of this study held other minority identities besides them being FGCSs. As reported in Table 1, 68% of the students belong to minority racial groups, 32% are international students, and 58% don’t speak English as their first language. Holding a minority identity besides being an FGCSs can lead to those students feeling

marginalized in a university community (6). In this study, we investigated the impact of belonging to a minority racial group on the academic performance of FGCSs. As shown in Figure 2, the GPA didn't vary widely based on racial groups. Yet, based on the collected qualitative data, some students expressed the challenges facing them because of holding a minority identity besides being an FGCSs. One of the study participants expressed the challenges related to holding a minority identity saying:

I feel that others--regardless of identifying [as] FGCS or not--do not understand where I come from. In my culture, it is expected for females to not attend college.... I feel that the biggest challenge I face as a FGCS is people not understanding how lost I am, and how I try to fit in on the expectations of an Asian in America, and the Lao woman I am supposed to be in the Lao community

The mentoring program was implemented to increase students' academic and professional development to ensure their success and retention in Biomedical Engineering. In previous studies, mentoring was found to help increase the retention of students especially those who belong to minority groups (21, 23). Although the University of Arkansas offers Path program to help FGCSs navigate college, only 5% of this study participants have reported being a Path program member. As a result, more advertisements for programs that are designed to help FGCSs navigate college should be enforced.

The mentoring program included helping the students navigate the challenges facing them in either the Biomechanical Engineering or Biomolecular Engineering classes. Furthermore, the mentors gave the students guidance on how to use the metacognition theory and knowledge about their learning styles to achieve better learning. In addition to peer mentoring or faculty mentoring, academic coaching was an integral part of this study. The academic coach has given the students guidance on how to navigate their academics such as learning about routine, time management, mitigating distractions, and planning ahead. As a result of COVID-19 issues, the University of Arkansas has moved all classes to online platforms. The academic coach was able to help guide the study participants on how to navigate online classes. One of the participants commented in the post-mentoring survey that "Speaking with the Academic Coach, Rachel Piontak, really made [him/her] focus on how [he/she] will be using [his/her] time during

online classes”. Another participant reported that “[he/she] received good advice on how to adjust to all classes online”.

To investigate the impact of the mentoring program on the academic performance of FGCSs, their grades in the Biomechanical Engineering or Biomolecular Engineering classes were collected, per IRB protocol, prior to and post the mentoring program. For the Biomechanical Engineering class, the participants' average scores in quizzes 6 and 7 were significantly higher than their average scores in quizzes 6 and 7 as shown in Figure 3 ( $p=0.007$ ). One of the participants acknowledged the role of the mentoring program in enhancing his/her performance in the Biomechanical Engineering class as reported in Table 8 by saying:

Before the mentoring service, I had already made a low C on Exam 1 in Biomechanics. Right before the end of the mentoring service, I was able to make 95 on Exam 2. I feel like the service was very beneficial to me in that it allowed me to connect with another peer that had experienced some of the same things academically that I have and that was also currently experiencing similar academic challenges to me.

The findings regarding the impact of mentoring on the academic performance of students in the Biomechanical Engineering class were similar to the findings of previous literature that reported that mentoring programs can enhance the academic performance of students in engineering (21). Contrary to the pattern of participants' grades in the Biomechanical Engineering grades, the grades of the participants in the Biomolecular Engineering class were significantly lower post the mentoring program compared to their grades prior to the mentoring program as shown in Figure 4 ( $p=0.0001$ ). These findings disagree with the previous literature results, but it might be due to a varied level of difficulty among the Biomolecular Engineering materials and quizzes. In addition, it should be taken into consideration that the scores of quizzes 6 and 7 could have been affected by the transition of the classes into online platforms as a response to the COVID-19 situation. Online learning and taking the quizzes online could have had an impact the students' performance. In addition, the University of Arkansas has passed a policy to allow the students to change their A, B, or C letter grades into (Pass), and D letter grade into (Pass D) in their transcripts. These newly implemented policies besides the overall challenging situation due to the COVID-19 could have had an impact on the students' performance in the quizzes administered post the mentoring program. Further investigation of the scores of the students in

Biomolecular Engineering quizzes over multiple semesters should be conducted to gain more insights. In addition, many of the students in the Biomolecular Engineering classes are either juniors or seniors, whereas the students in the Biomechanical Engineering classes are mostly sophomores. The effect of mentoring programs on enhancing the academic performance of several class standing groups should be further investigated.

FGCSs are susceptible to having internal beliefs about themselves that can hinder their academic performance such as their self-confidence and belongingness (12-14). Both confidence and belongingness were found to be very important factors in the success of FGCSs and their integration into the university and the engineering communities (12-14). The content of the confidence questionnaire that was used in this study is shown in Table 5. Overall, the confidence of the students was significantly increased after the mentoring program with respect to their confidence prior to the mentoring program as shown in Figure 6 and Figure 7 ( $p=0.0003$ ). When the participants were grouped based on the mentoring style they had (faculty or peer mentoring), their overall confidence was still significantly higher after the mentoring program with respect to their confidence prior to the mentoring program as shown in Figure 8 and Figure 9 ( $p=0.003$ ;  $p=0.006$  for faculty and peer mentoring respectively).

The belongingness of the participants was also evaluated before and after the mentoring program. The content of the belongingness questionnaire is shown in Table 6. Overall, the belongingness of the students was higher after the mentoring program with respect to their belongingness before the mentoring program as shown in Figure 10 and Figure 11 but the difference wasn't statistically significant ( $p=0.07$ ). When the participants were grouped based on the mentoring style they had (faculty or peer mentoring), faculty-mentored students showed an increase in their belongingness after the mentoring program with respect to the belongingness before the mentoring program as shown in Figure 12 a-b and Figure 13 but the difference wasn't statistically significant ( $p=0.07$ ). Peer-mentored students showed an increase in their belongingness after the mentoring with respect to their belongingness before the mentoring as shown in Figure 12 a-b and Figure 13 but the difference wasn't statistically significant ( $p=0.12$ ). Further investigation of the belongingness of FGCSs should be conducted. Moreover, the mentoring program should be edited to include aspects that focus on the inclusion and integration of FGCSs in the Biomedical Engineering community.

The future goals of the study participants were examined and reported in Table 7. The participants' career goals were almost evenly split between graduate school (32%), medical or dental school (21%), industry (26%), or other careers (21%). Since involvement in both professional and extracurricular opportunities is important for preparing for future careers, the involvement of the study participants in both professional opportunities and extracurricular activities was examined as shown in Table 7. As reported in Table 7, only 16% of the participants have participated in professional opportunities such as research opportunities, internships, and/or co-ops. This might be due to the lack of knowledge in how important these opportunities are towards building up their career or the lack of experience on how to apply for these professional opportunities. One of the participants stated in the pre-mentoring survey that "one challenge would be to not have someone with experience to help [him/her] choose [his/her] career path." Another participant also described in the pre-mentoring survey that "[he/she] couldn't/ can't rely on [his/her] parents for advice for what [he/she] can do to prepare [him/her] for post-grad. For instance: what [he/she] can do to ensure [his/her] success when it comes to grad school, how to go about making connections for the future, etc.". To overcome these challenges, the mentoring program focused on helping the students navigate their career plans and helping them explore how to prepare for their prospective careers. The number of students involved in professional opportunities after the mentoring program increased when compared to the number of participants involved in professional opportunities before the mentoring as demonstrated in Figure 14. It should be taken into consideration that the post-mentoring survey was collected shortly after the end of the mentoring program, which didn't allow for enough time for the students to get involved. Furthermore, due to the COVID-19 pandemic, applying for professional opportunities such as internships or research opportunities is currently more challenging. In the mentoring program, participants were introduced to the importance of these opportunities and how to approach them. One of the participants stated in the post-mentoring survey that the mentoring program "helped [him/her] to learn more about the coaching engineering program and a formal way to request participation in an internship or another Biomedical Engineering activity". Another participant reported that "[he/she] was given tips on how to approach professors for research opportunities which I believe will be useful". These skills on how to approach professional opportunities will be beneficial for increasing the FGCSs involvement in these opportunities.

One of this study limitations is the sample size. Due to the small sample size, Exploratory Factor Analysis were not conducted over the belongingness and confidence Likert scale questionnaires which could have provided further insights into the common factors of belongingness and confidence of FGCSs. In addition, the belongingness and confidence questionnaires, although used by multiple studies, could be interpreted differently from one student to another. The study assumed that the questionnaires were interpreted similarly by all the students. Another limitation of this study is the self-reported information by the students such as GPA and working hours which is susceptible to student's accuracy in reporting the data.

## **5. Conclusion**

In this study, multiple challenges facing FGCSs were identified. These challenges included the lack of guidance on how to navigate academic and career-related decisions. Moreover, some of the study participants have described how having a minority identity besides being an FGCSs adds to the challenges facing them, as it is hard to find individuals around who understand these challenges. Previous literature found that FGCSs are at higher risk of dropping out of STEM fields compared to CCSs (4, 10). Due to the multidisciplinary nature of the Biomedical Engineering field, students are required to integrate multiple fields together and to adapt the methodological approach to each discipline(15, 16). The added challenge of studying a multidisciplinary field to the challenges facing FGCSs in STEM fields, requires us to focus on how to ensure the success and retention of FGCSs in multidisciplinary STEM fields such as Biomedical Engineering. There is currently a gap in the literature about the challenges facing FGCSs in multidisciplinary STEM fields such as Biomedical Engineering and how to maximize their academic success in these fields. This study focused on identifying and analyzing those challenges facing FGCSs in multidisciplinary STEM fields and employing faculty mentoring combined with academic coaching or peer mentoring program combined with academic coaching to maximize their academic and professional success. Factors such as race and working were examined to determine their impact on FGCSs in Biomedical Engineering. It was found that although the GPA of FGCSs who didn't work was slightly higher than the GPA of FGCSs who worked, the difference wasn't statistically significant. Variation of the means of the GPA was also observed over different racial groups; however, the difference wasn't significant.

The impact of the mentoring programs on the academic and professional performance of FGCSs was examined. The FGCSs grades in the Biomechanical Engineering class were significantly improved after the mentoring program compared to their grades prior to the mentoring program. This could be attributed to the role of the mentoring program in helping the students navigate the challenges in the Biomechanical Engineering class. Also, the mentoring program addressed the use of metacognition theory to achieve academic success. Besides, the academic coach has provided the students with guidance on how to navigate time management and study habits, and online classes due to the COVID-19 situation. Contrary to the FGCSs performance in Biomechanical Engineering, participants who were enrolled in the Biomolecular Engineering class had lower averages for quizzes post the mentoring compared to their average grades prior to the mentoring. This could have been due to a different level of difficulty of the Biomolecular Engineering class. Moreover, the switch of classes into online platforms due to the COVID-19 might have impacted students' performance. Further investigation of the grades of students in Biomolecular Engineering in different semesters could give insights about the level of difficulty of the material post the mentoring program compared to the level of difficulty of the materials prior to the mentoring program.

The results of this study showed that peer mentoring combined with academic coaching or faculty mentoring combined with academic coaching led to a significant increase in the confidence of FGCSs. This could be attributed to the guidance and support mentors and academic coach can provide to FGCSs on how to reach their potential and achieve academic and professional success. The results of the study also indicated that the belongingness of FGCSs wasn't significantly affected by the mentoring program. This could be addressed by adding more components to the mentoring program that focusses on the inclusion of FGCSs ensuring their integration into the Biomedical Engineering Department community. The involvement of FGCSs in professional or extracurricular opportunities increased after by the mentoring program. Multiple students have stated in the post-mentoring survey that they have gained insights on how to approach professional opportunities. Following up with the study participants and examining their involvement in professional and extracurricular opportunities could give more insights on how the mentoring program has impacted their professional development.



## **6. Future directions**

To gain more insights into the subcategories of confidence and belongingness of FGCSs, Exploratory Factor Analysis (EFA) should be conducted (24, 25). EFA will allow us to define the common factors within the confidence and belongingness questionnaire. For the mentoring program, pairing the students to their peer mentors based on the similarity of career goals should be implemented. This will allow the mentees to benefit more from the experience of the peer mentors on how to plan for future careers. Moreover, providing more mentoring meetings with pre-announced details where students get to choose which meetings they need to attend, would ensure the students get guidance in the areas that each of them needs. Lastly, a longitudinal study should be conducted to investigate the impact of the mentoring program on FGCSs' professional success throughout and after college.

## **7. Acknowledgments**

First and foremost, I would like to acknowledge my Honors thesis advisor, Dr. Mostafa Elsaadany, for the limitless guidance and support throughout this study. In addition, I would like to acknowledge Dr. Elsaadany for being the faculty mentor for the study. I would like to acknowledge Rachel Pointak, the academic coach at the College of Engineering at the University of Arkansas, for conducting academic coaching sessions for the study participants. Finally, I would like to acknowledge the teaching assistants of the Biomolecular Engineering and Biomechanical Engineering classes, Spring 2020, for serving as peer mentors in this study.

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# **Appendix I: Informed Consent**

**How do we maximize the academic success of biomedical engineering first-generation college students?**

## **Consent to Participate in a Research Study**

Principal Researcher: Mona Ahmed

Faculty Advisor: Dr. Mostafa Elsaadany

### **INVITATION TO PARTICIPATE**

You are invited to participate in a research study about the factors contributing to the inclusion and academic success of first-generation college students (FGCSs) at the University of Arkansas Biomedical Engineering Department. You are being asked to participate in this study because you are a Biomedical Engineering student who is currently enrolled in one of the following classes at the University of Arkansas: Biomechanical Engineering or Biomolecular Engineering, and you are a first-generation college student.

### **WHAT YOU SHOULD KNOW ABOUT THE RESEARCH STUDY**

*Who is the Principal Researcher?*

Mona Ahmed

Email: [maa025@uark.edu](mailto:maa025@uark.edu)

*Who is the Faculty Advisor?*

Dr. Mostafa Elsaadany

Email: [mselsaad@uark.edu](mailto:mselsaad@uark.edu)

*What is the purpose of this research study?*

The purpose of this study is to identify effective strategies that can lead to the inclusion and academic success of FGCSs in multidisciplinary STEM fields.

*Who will participate in this study?*

Approximately 30 FGCSs who are enrolled in either the Biomolecular Engineering or Biomechanical Engineering classes at the University of Arkansas for the Spring semester of 2020. The participants must be 18 years old and above.

*What am I being asked to do?*

Your participation will require the following:

- 1- Filling pre-mentoring survey (15 minutes)
- 2- Attending four mentoring sessions, one every two weeks, with either a peer mentor or a faculty mentor between February 1<sup>st</sup>, 2020 and April 1<sup>st</sup>, 2020. Each session will last for 15 minutes
- 3- Attending one mentoring session with an academic coach. The meeting will last between 30 – 50 minutes.
- 4- Filling Post-mentoring survey (15 minutes)

*What are the possible risks or discomforts?*

There are no anticipated risks to participating in this study.

*What are the possible benefits of this study?*

The benefits of participation in this study include obtaining extra credit in either the Biomolecular Engineering class or the Biomechanical Engineering class. Additionally, participants will have mentorship meetings that can provide guidance on how to achieve success at the University of Arkansas Biomedical Engineering Department.

*How long will the study last?*

This study will take place between January 13<sup>th</sup>, 2020 and May 7<sup>th</sup>, 2020. Participants will need to fill two 15-minute surveys, attend four 15-minute meetings with either a faculty mentor or a peer mentor, and attend one 30-50 minute meeting with an academic coach. The surveys and meetings will be spread over two months.

*Will I receive compensation for my time and inconvenience if I choose to participate in this study?*

Yes, you will receive extra credit in either the Biomolecular Engineering class or the Biomechanical Engineering class.

*Will I have to pay for anything?*

No, participation in this study will **not** cost you any payment.

*What are the options if I do not want to be in the study?*

If you do not want to be in this study, you may refuse to participate. Also, you may refuse to participate at any time during the study. Your grades and academic standing in the Biomolecular Engineering or/and the Biomechanical Engineering classes will not be affected in any way if you refuse to participate.

*How will my confidentiality be protected?*

All information will be kept confidential to the extent allowed by applicable State and Federal law.

All the data collected will be kept in a secure domain. Pseudonyms will be assigned to each participant to ensure their confidentiality during the data analysis and any further reporting processes. The participants names will **not** be included in any reported or published data.

Please note that grades and class assignments will be included in the research data.

Confidentiality will be protected as above.

*Will I know the results of the study?*

At the conclusion of the study, you will have the right to request feedback about the results. You may contact the faculty advisor, Dr. Mostafa Elsaadany ([mselsaad@uark.edu](mailto:mselsaad@uark.edu)) or Principal Researcher Mona Ahmed ([maa025@uark.edu](mailto:maa025@uark.edu)). You will receive a copy of this form for your files.

*What do I do if I have questions about the research study?*

You have the right to contact the Principal Researcher or Faculty Advisor as listed below for any concerns that you may have.

Mona Ahmed ([maa025@uark.edu](mailto:maa025@uark.edu))

Dr. Mostafa Elsaadany( [mselsaad@uark.edu](mailto:mselsaad@uark.edu))

You may also contact the University of Arkansas Research Compliance office listed below if you have questions about your rights as a participant, or to discuss any concerns about, or problems with the research.

Ro Windwalker, CIP  
Institutional Review Board Coordinator  
Research Compliance  
University of Arkansas  
109 MLKG Building  
Fayetteville, AR 72701-1201  
479-575-2208  
[irb@uark.edu](mailto:irb@uark.edu)

I have read the above statement and have been able to ask questions and express concerns, which have been satisfactorily responded to by the investigator. I understand the purpose of the study as well as the potential benefits and risks that are involved. I understand that participation is voluntary. I understand that significant new findings developed during this research will be shared with the participant. I understand that no rights have been waived by signing the consent form. I have been given a copy of the consent form.

## **Appendix II: Surveys**

### **Pre-mentoring Survey**

Name

UARK email address

From the 3 listed classes below, check all the ones that you are enrolled in this semester

- Biomolecular Engineering BMEG 3824
- Honors Biomolecular Engineering BMEG 3824H
- Biomechanical Engineering BMEG 2813

Are you a First-Generation College Student (students that neither of their parents has earned a college degree)?

- Yes
- No

Do you have any siblings who earned a college degree?

- Yes
- No

Are you a member of "Path" program?

- Yes
- No

Check all that characterize your race:

- American Indian or Alaskan Native
- Asian
- Hispanic or Latino
- Black or African American
- White
- Native Hawaiian or Other Pacific Islander
- Other

If you chose other, please clarify

Gender

- Female
- Male
- Other

Are you an international student?

- Yes
- No

Is English your first language?

- Yes
- No

How many credit hours are you taking this semester?

What is your class standing?

- Sophomore
- Junior
- Senior
- Other

If you chose other, please clarify

Are you enrolled in the Honors Program?

- Yes

No

What's your current cumulative GPA?

Do you feel isolated or depressed? And how do you keep with it?

Are you aware of the services offered by the UARK wellness center?

Yes

No

If yes, how often do you use the services of the Wellness center?

Are you aware of the services offered by the UARK Counseling and Psychological Service (CAPS)?

Yes

No

If yes, how often do you use the services offered by CAPS?

Do you work?

Yes

No

How many hours do you work per week?

Does work affect your studying time? Please explain briefly.

Do you have a faculty mentor? (A faculty member that you usually consult with and discuss your plans or the challenges you are facing)

Yes

No

If yes, how did your faculty mentor contribute to your academic performance?

What are your goals after graduation?



- Graduate School
- Medical School or Dental School
- Industry
- Other

If you chose other, please clarify

Did you participate in an internship or research experience since you started your degree at the U of A?

- Yes
- No

If yes, please list those internships or research experiences

Are you involved in leadership or extracurricular activities?

- Yes
- No

If yes, please list those leadership or extracurricular activities

### **Confidence Questionnaire**

**For the following statements, select the choice that describes you the most**

I am well suited for my choice of college major

Strongly agree, agree, neutral, disagree, strongly disagree

I am confident in my overall academic ability

Strongly agree, agree, neutral, disagree, strongly disagree

I am confident in my ability to succeed in my college engineering courses

Strongly agree, agree, neutral, disagree, strongly disagree

I am competent in the skills required for my major

Strongly agree, agree, neutral, disagree, strongly disagree

I am confident that someone like me can succeed in an engineering career

Strongly agree, agree, neutral, disagree, strongly disagree

I expect that engineering will be a rewarding career

Strongly agree, agree, neutral, disagree, strongly disagree

I will have no problem finding a job when I have obtained an engineering degree

Strongly agree, agree, neutral, disagree, strongly disagree

My engineering coursework will prepare me for a job in engineering

Strongly agree, agree, neutral, disagree, strongly disagree

Compared to other students in my classes, I think my academic abilities in my engineering classes

Far below average, below average, average, above average, far above average

### **Belongingness Questionnaire**

**For the following statements, select the choice that describes you the most**

People in the Department of Biomedical Engineering like me.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel like I belong in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I fit in well in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel comfortable in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering are a lot like me.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel like a real part of the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering notice when I'm good at something.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

It is hard for people like me to be accepted in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

Other students in the Department of Biomedical Engineering take my opinions seriously.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

Sometimes I feel as if I don't belong in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering are friendly to me.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I am included in a lot of activities in the Department Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I am treated with as much respect as other students in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel very different from most other students in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I can really be myself in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering know I can do good work.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel proud of belonging to the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

Other students in the Department of Biomedical Engineering like me the way I am.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

If you are a First-Generation College Student (FGCS), what are some of the challenges that face you as an FGCS?

What are some of the factors that you think contributed to your success at the U of A?

## **Post mentoring survey**

Name:

UARK email address:

From the 3 listed classes below, check all the ones that you are enrolled in this semester

- Biomolecular Engineering BMEG 3824
- Honors Biomolecular Engineering BMEG 3824H
- Biomechanical Engineering BMEG 2813

Which mentorship did you have? (Check all that apply)

- Peer mentor
- Faculty mentor
- Academic coach

Do you feel isolated or depressed? And how do you deal with that?

Are you aware of the services offered by the UARK wellness center?

- Yes
- No

If yes, how often do you use the services of the Wellness center?

Are you aware of the services offered by the UARK Counseling and Psychological Service (CAPS)?

- Yes
- No

If yes, how often do you use the services offered by CAPS?

Did you participate in an internship or research experience since you started your degree at the U of A?

- Yes
- No

If yes, please list those internships or research experiences

Are you involved in leadership or extracurricular activities?

- Yes
- No

If yes, please list those leadership or extracurricular activities

### **Confidence Questionnaire**

**For the following statements, select the choice that describe you the most**

I am well suited for my choice of college major

Strongly agree, agree, neutral, disagree, strongly disagree

I am confident in my overall academic ability

Strongly agree, agree, neutral, disagree, strongly disagree

I am confident in my ability to succeed in my college engineering courses

Strongly agree, agree, neutral, disagree, strongly disagree

I am competent in the skills required for my major

Strongly agree, agree, neutral, disagree, strongly disagree

I am confident that someone like me can succeed in an engineering career

Strongly agree, agree, neutral, disagree, strongly disagree

I expect that engineering will be a rewarding career

Strongly agree, agree, neutral, disagree, strongly disagree

I will have no problem finding a job when I have obtained an engineering degree

Strongly agree, agree, neutral, disagree, strongly disagree

My engineering coursework will prepare me for a job in engineering

Strongly agree, agree, neutral, disagree, strongly disagree

Compared to other students in my classes, I think my academic abilities in my engineering classes

Far below average, below average, average, above average, far above average

### **Belongingness Questionnaire**

**For the following statements, select the choice that describes you the most**

People in the Department of Biomedical Engineering like me.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel like I belong in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I fit in well in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel comfortable in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering are a lot like me.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel like a real part of the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering notice when I'm good at something.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

It is hard for people like me to be accepted in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

Other students in the Department of Biomedical Engineering take my opinions seriously.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

Sometimes I feel as if I don't belong in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering are friendly to me.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I am included in a lot of activities in the Department Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I am treated with as much respect as other students in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel very different from most other students in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I can really be myself in the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

People in the Department of Biomedical Engineering know I can do good work.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

I feel proud of belonging to the Department of Biomedical Engineering.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

Other students in the Department of Biomedical Engineering like me the way I am.

Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

How did the mentorship program contribute to your academic performance?

What do you think could be improved in the mentorship program?