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Bridging the Great Divide: A Strategy for How Online Graduate Students Can Participate and Enhance the Education of Undergraduate Students

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As a Ph.D. candidate enrolled in the University of North Dakota's Biomedical Engineering Program, I am actively engaged in an enriching Innovative-Based Learning (IBL) experience. Within this dynamic academic setting, I have undertaken a leadership role in groundbreaking research focused on Parkinson's disease, collaborating seamlessly with a diverse cohort of both online and in-person graduate and undergraduate students.

One of my greatest sources of satisfaction lies in leveraging my knowledge and skills to mentor undergraduate students, guiding them in the refinement of their research and professional capabilities. I take immense pride in fostering an inclusive and collaborative environment where students can thrive, encouraging their academic growth and contributing to the broader community of biomedical engineering scholars.

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Bridging the Great Divide: A Strategy for How Online Graduate Students Can Participate and Enhance the Education of Undergraduate Students

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Abstract

In the current landscape dominated by virtual education, a distinctive opportunity arises to enrich the learning and experiences of undergraduate (UG) students. This enhancement stems from collaborative engagement with on-campus and online graduate students who, without the presence of online programs prioritizing their integration, would be unable to contribute. This collaborative approach allows UG students to glean insights from a more diverse and comprehensive range of graduate students, fostering relationships that might otherwise remain unrealized.

In the context of fostering collaborative relationships between graduate and UG students, implementing an innovative-based learning (IBL) program serves as a catalyst for synergy. The IBL program involves interdisciplinary projects that require collaboration between graduate and undergraduate students. These projects provide opportunities for innovation, addressing real-world problems, and leveraging the diverse skills of each student. The exchange of ideas becomes a reciprocal process, enriching the learning experience for all involved. This program facilitates knowledge transfer and strengthens the bonds between diverse student groups by integrating innovative educational approaches. With the addition of integrating online graduate students, an IBL program can provide a more diverse and well-rounded group of graduate students to participate in the enhancement of the learning experience of undergraduate students. However, online graduate students face unique challenges in fostering relationships with in-person undergraduates, such as time zone differences, technology, building personal connections, and the potential for miscommunication.

This research aims to assess graduate students' value in enhancing undergraduate students' learning through collaborative projects in an IBL program. Additionally, this research analyzes how this model empowers graduate students to play a pivotal role in helping UG students hone skills. Lastly, the research analyzes perceived challenges online graduate students face when trying to foster relationships with UG students when teaching skills. To accomplish this, two surveys were given to UG or graduate students in an IBL program to assess UG's perceived growth in skills and value of graduate students and the challenges online students face in fostering growth in UG students.

Analysis of responses found that while UG students value graduate students in their project groups, graduate students are only able to foster growth in freshman UG students and not in sophomores or juniors. This inability to foster growth in sophomore and junior UG students may be because graduate students are not interacting with these UG students in a way that fosters growth. Additionally, analysis of the results found that, generally, online students only feel they face one challenge when trying to teach undergraduate students new skills. This paper proposes a strategy for how online graduate students can overcome this challenge and enhance the learning experience of UG students. Additionally, this paper proposes additional recommendations on how to foster growth more effectively in areas found ineffective by the analysis.

This paper contributes to the ongoing discourse on mentorship in higher education by presenting a blueprint to optimize graduate student interaction with UG students to foster growth across the digital-physical divide, emphasizing the potential for online graduate students to emerge as successful mentors. The findings underscore their ability to bridge geographical disparities in higher education and foster rich collaboration in various learning environments for all students.

Introduction

In recent years, the COVID-19 pandemic has significantly pushed for more virtual education opportunities in higher education, where educational institutions had no choice but to resort to virtual teaching methods [1]. However, the COVID-19 pandemic alone does not fuel the need for more access to virtual education opportunities; advances in communication technology, overcoming gender educational disparities or geographical boundaries, and supporting lifelong learning are all environmental stressors that push for more access to virtual education [2]. In addition to providing more virtual educational experiences for students, there is a growing emphasis on ensuring that higher education also equips all students, whether in person or online, with skills that align with the needs of the industry [3]. One way education tries to equip students with skills the industry needs more effectively is by implementing innovation-based learning (IBL) [4,5].

IBL is a teaching paradigm where courses require both undergraduate (UG) and graduate students to learn fundamental engineering concepts during class sessions. Then, these students engage in collaborative projects that aim to tackle real-world problems to teach not only fundamental engineering concepts but also skills that have been deemed essential for the workplace [4.5]. Students within these projects are required to create externalized value and share their work outside of the classroom. The type of externalized value can range from attending conferences and symposiums or submitting works to scholarly journals for publications to share their work. Externalized value can also be the creation of patents and businesses [6]. While all UG and graduate students are actively learning and building their engineering and workplace skill sets, the collaborative projects provide UG students with an additional unique opportunity. Specifically, UG students not only gain knowledge about engineering within the classroom setting but also have the opportunity to learn from their interactions with graduate students in the project setting. This type of learning environment leverages both coursework and insights from more advanced peers to provide UG students with a more comprehensive and effective educational experience [4,5,6,7,8,9].

Universities implementing the IBL model have also made great efforts to seamlessly integrate UG and graduate online students into the learning environment, allowing online students to gain a more authentic engineering educational experience [4]. Additionally, incorporating online students allows for the opportunity for students to work in teams that are both diverse in discipline and must work virtually to produce deliverables, another skill that has been deemed necessary for industry [4]. The effectiveness of this type of interaction has been successful—in a pilot cardiovascular engineering course where UG and graduate students worked together in teams. The study wanted to analyze if teams of students, including online students, could be just as successful as on-campus students. The study found that teams with online students produced deliverables as successfully as teams who only met in person [4]. Additional research specifically looked at a team of students in this course who faced a multitude of barriers, such as varying in geographical location with students being in different time zones, and in educational experience with students having different academic levels, from UG students to students in master's programs and Ph.D. programs. The study found that this team successfully met all course expectations, suggesting that having online students did not hinder success [10]. This research indicates that UG and graduate students can work together successfully, and that having online students participate does not hinder the success of the projects. This teaching paradigm also offers a unique opportunity for UG students to work and learn from graduate students, offering a way to enhance UG students' learning. A study by Feldman [11] supports this by showing that in these educational-level diverse group projects, students learned skills by taking on roles as apprentices who learned from mentors. The apprentices gain skills through hands-on experience and interaction with their mentors. Furthermore, they found that graduate students take on more of the role of mentors compared to UG students [11].

The combined research supports that diverse project groups, in terms of education level and instructional method, can succeed in the IBL paradigm. Additionally, it shows that graduate students can transfer knowledge and skills to UG students in these projects in person. However, there is a need for research that analyzes if online graduate students can form these relationships with UG students to transfer knowledge and enhance skills effectively to UG students.

This research aims to assess the effectiveness of graduate students in a Biomedical Engineering program at the University of North Dakota in eliciting growth in the skills of UG students when engaging in a collaborative project, whether online or in person. This research also aims to assess the perceived challenges of online graduate students in developing this growth in UG students. The results of this research show that UG students value the participation of graduate students in their collaborative project groups, regardless of the instructional method. Furthermore, the results suggest that graduate students can foster growth through collaborative projects in the IBL paradigm, but only for freshman students. The results suggest that graduate students must interact in a certain way with UG students to foster growth effectively and that this behavior may be more prevalent when graduate students interact with freshmen than higher-level UG student classes. Lastly, the results show that online graduate students generally do not perceive any challenges to being online that would hinder them from fostering skill growth in UG students. Together, these results suggest that being online does not impede graduate students from effectively encouraging growth in UG students. Rather, graduate students do not interact with the sophomore and junior UG students in certain ways that effectively fosters perceived growth. Upon these results, recommendations are given to IBL programs to help graduate students, online and in person, to learn how to interact with UG students to foster growth more effectively.

Methods

UG Student Survey

A UG student survey was created to assess the impact of graduate students on the growth of UG students in these collaborative projects. This survey aimed to measure the perceived growth in skills of UG students who were engaged in these projects. UG students assessed their perceived growth in skills and their perception of how graduate students influenced that growth through a twenty-question survey (see Appendix A). In this survey, the first question was a multiple-choice question that asked what class they were in: freshman, sophomore, junior, or senior. The first section of the UG survey, ten questions using a Likert scale from 1 to 5, 1 representing minimal growth and 5 indicating significant improvement, were used to analyze UG students' perceived growth in the following skills:

- Sketching and conceptualizing
- Creating detailed designs
- Utilizing design software
- Practical implementation of design
- Coding/programming
- Handling tools and equipment
- Utilizing testing tools
- Speaking clearly and coherently during oral presentations
- Engaging with an audience during oral presentations
- Handling questions and feedback during oral presentations

The second part of the survey used two multiple-choice and three open-ended response questions to assess UGs' expectations about collaborative projects and asked what skills they hoped to gain from the project. The last part of the UG survey used two multiple choice questions and a Likert scale from 1 to 5, 1 indicating minimal involvement and 5 indicating a high level of involvement, and one open response question to assess UG's perception of how active graduate students are in projects and if graduate students are beneficial to help UG students grow in the skills mentioned above.

Graduate Student Survey

Graduate students determined the perceived challenges and advantages of their instructional setting, whether in person or online, in mentoring UG students in a collaborative project through a seven-question survey (see Appendix B). The graduate student survey used three multiple choice and four open-ended response questions to assess instructional setting and perceived challenges graduate students face based on their instructional setting.

Participants and Data Collection

An online instructional platform, MOOCIBL [6,7,12], collected and recorded all thirty-one responses from students who were all engaged in an IBL Biomedical Engineering Program course at the University of North Dakota. Of this sample, twenty-two responses were from undergraduate students: eleven freshmen, seven sophomores, and four juniors. Of this sample, nine responses were from graduate students, seven Ph.D. students, and two master's students. Of the graduate students, there were five Ph.D. students and one master's student who had an online instructional setting. The responses were then exported into Microsoft (MS) Excel for statistical analysis. The Institutional Review Board (IRB) approved the current study (IRB protocol #IRB0005373).

Data Analysis

Several statistical analyses were conducted using MS Excel to analyze UG's perceived growth and how graduate participation influenced it. An ANOVA analysis was conducted to investigate whether the presence of a graduate student impacted perceived growth across all three classes of undergraduate students. Independent t-tests, using a 95% confidence interval, were used to analyze the differences in perceived growth between UG class years and the abovementioned skills and to determine which classes graduate students could foster growth in. A correlation analysis was then used to determine how the activity of graduate students impacted perceived growth.

Generative AI was used to analyze common themes in open-ended responses of UG students about what expectations they had about the project, what skills they sought to gain, and their thoughts on graduate student involvement. Generative AI was also used to analyze open-ended responses of graduate students about perceived challenges based on their instructional setting. Responses were pasted into the generative AI message box with the following prompt, "Tell me the top three trends based on this feedback."

Results and Discussion

Perceived Growth and Expectations of Undergraduate Students

Across all skills, UG students had an average perceived growth rating of 3.23 on the 5-point Likert Scale. On average, the skill with the most perceived growth was "speaking clearly and coherently during oral presentations," and the lowest was "coding/programming." Table 1 lists all average perceived growth scores for each skill. Interestingly, learning technical skills such as coding was the top-trending theme for what skills UG students hoped to gain from the project, followed by project understanding and professional and soft skill enhancement. However, coding/programming scored the lowest in perceived growth, suggesting a demand and a need to implement more opportunities for UG students to engage with technical development skills, specifically in coding. However, coding is a difficult skill to learn for students, especially for UG students who have not yet developed the skills needed to support coding, like understanding how to apply it to the field and advanced equations and algorithms, making students often feel high levels of frustration when trying to learn to code and lower levels of confidence in the skill [13,14,15]. These factors could influence perceptions around growth in this skill, making UG students underscore their growth, and the impact graduate students have on this skill. The least trending skill UG students hoped to gain from the project was presentation skills; only one UG student mentioned wanting to gain presentation skills. However, it was the highest average perceived growth score, suggesting ample opportunity for UG students to gain presentation skills.

There was a statistically significant difference between the perceived growth of freshman students compared to sophomores or juniors, resulting in a p-value of <0.0001 for both. This relationship became less significant when comparing perceived growth scores between sophomores and juniors, resulting in a p-value $= 0.014$. These results suggest that when engaged in collaborative projects, freshmen tend to feel that they have grown more in skills when compared to students in higher classes and that the perception of growth gets smaller as UG students advance to high academic class levels.

Table 1: Average Perceived Skill Growth Scores amongst Undergraduate Students

Perceived growth Score / *Skill*	*Average*	*Min*	*Max*	*Median*	*Standard Deviation*
Sketching and conceptualizing	3.23	1	5	3	0.94
Creating detailed designs	3	1	5	3	1.04
Utilizing Design Software	3.27	1	5	3	1.52
Practical implementation of design	3.5	1	5	4	1.03
Coding/Programming	2.18	1	5	1.5	1.50
Handling tools and Equipment	2.73	1	5	3	1.42
Utilizing testing tools	2.77	1	5	3	1.54
Speaking clearly and coherently during oral presentations	4.0	1	5	4	0.72
Engaging with an audience during oral presentations	3.77	1	5	4	0.92
Handling Questions and Feedback during Oral Presentations	3.82	1	5	4	1.05

How Graduate Student Involvement Impacts Perceived Growth

To understand how graduate student involvement impacts UG students perceived growth scores across all classes, an ANOVA test was conducted that compared the mean perceived growth scores of freshmen, sophomores, and juniors who either had a graduate student in their project group or did not. The analysis found a statistically significant difference in the perceived growth score of UG students based on graduate student participation in the same project, with a p-value of 8.01E-06. These results suggest that graduate students can foster growth in skills in UG students.

Independent sample t-tests were then conducted to further analyze how graduate student involvement impacts each group differently. The analysis shows a statistically significant difference in perceived growth scores depending on graduate student participation, but only amongst freshman students, with a p-value of 0.0001. Sophomore and junior classes did not show the same difference in perceived growth scores based on whether they had a graduate student in their project group, with p values equal to 0.7183 and 0.0818, respectively. These results suggest that while graduate students are successful at fostering growth in freshmen, they are unsuccessful at promoting growth in sophomore or junior UG students. These results may account for why freshman had significantly higher perceived growth scores when compared to their higher-class level peers. However, UG students who did not have a graduate student in their group were asked if they felt incorporating one in the future would help them reach their goals. Five UG students fit this category: one freshman, three sophomores, and one junior; all five UG students thought that incorporating one in the future would have an impact on helping them reach their goals. Even though the t-test results suggest that graduate students do not cause significant differences in the perceived growth of sophomores and juniors, the UG students still value their involvement in their projects.

Another independent sample t-test compared differences between UG students with graduate students in their project based on whether graduate students asked the UG students how confident they were in their skills and what skills they wanted to gain. The test found a statistically significant difference in groups, with a p-value of 0.0023, suggesting that asking this question was important for graduate students to foster growth in UG students. Additionally, a correlation analysis was conducted between the mean perceived growth score across UG students and their perception of how active the graduate student was in their project. The correlational analysis found a moderately positive correlation between the perceived growth of UG students and graduate activity levels, with a correlation coefficient of 0.455. These results suggest that how graduate students interact and how often they interact with UG students influences how effective they are in fostering growth in skills.

These results suggest that all classes highly value graduate student involvement. However, there are differences in the ability to foster growth depending on UG students' academic class level, where freshman students have significant differences in perceived growth compared to peers in higher class levels. Coupled with the decrease in perceived growth as undergraduate students progress to higher-class levels, this finding may suggest that graduate students' effectiveness in fostering growth is influenced by their perception of UG students' engineering skill sets. Graduate students may perceive that freshmen generally have weaker engineering skill sets than their higher-class level counterparts since they are new to the program and have yet to take as many engineering courses. This perception may push graduate students to interact with freshmen differently and emphasize understanding their skill set and where they have interests in growing. This theory suggests that graduate students interact with older UG students differently because they believe they can be more independent in the project due to having more experience with these skills. However, this perception makes it so graduate students cannot significantly foster growth with UG students in higher class levels. Research showing that freshman students do indeed have less sophisticated problem-solving and general engineering skills supports the creation of this perception by graduate students [16].

Another aspect of group dynamics that may influence graduate students' influence on UG students' growth is the group's organization. In addition to finding that graduate students take on the roles of mentors when in projects with UG students, Feldman [11] found that students in tightly organized groups had more opportunities to increase their skill level because UG students had more opportunities to interact with a graduate student in a way that fostered learning between them. These results, coupled with the findings of the correlation analysis, suggest that the frequency of interaction between UG students and graduate students also influences growth. Again, the frequency of interaction between graduate students and freshmen could be due to graduate students perceiving them as having weaker skill sets, making graduate students interact with them more frequently. Together, these results suggest that how graduate students interact with UG students leads to skill growth and that merely having one is inadequate for driving growth.

Perceived Challenges and Advantages of Graduate Students on their Instructional Setting

Generally, online students did not indicate they perceived many challenges when mentoring UG students in an online instructional setting. Generative AI, specifically ChatGPT, found that online students perceive that being online poses many advantages. The three most common trends were that an online instructional setting allows students to be more flexible and handle their professional and personal lives more efficiently, it is easier to communicate with undergraduate students and enables them to connect with students regardless of location. One graduate student wrote:

"If anything, being online helps communication because I can reach out whenever, and I do not have to wait to see them."

However, while online graduate students generally felt they had no challenges, two online graduate students did express that they had challenges teaching UG students' certain skills; specifically, both students mentioned teaching 3D printing. However, online simulators, discussed later in this paper, can overcome this challenge. These results are significant because they are a basis to show that online students do not have challenges when it comes to interacting and mentoring UG students and are just as capable as in-person students in being mentors. These results agree with another study by Pearson [4], which found that project groups in an IBL course with online students participating were just as successful as teams who can meet face-to-face. These results also comply with another study conducted by Mansor & Ismail [17] that aimed to analyze engineering students' perceptions of online learning. This researcher found that most engineering students positively perceived online learning for engineering courses. This perception is not affected by learning style, suggesting that learning styles are also not a barrier for online students. These results suggest that online students do not face challenges that impede their level of success across many domains in higher education. These results should quell uncertainties that programs may have about including online students based on fears of them having too many challenges. This brings more opportunities for programs to increase the diversity of their students and provides a more significant opportunity for students to seek an education in a field they want without worrying about geographical barriers.

Overall, the compiled results show that online graduate students do not face challenges in fostering growth in UG students because they are online. Rather, there is an overall issue with how graduate students, both online and in person, interact with UG students of higher academic class levels, specifically sophomores, and juniors, that decreases their effectiveness in fostering growth in UG students through a collaborative project.

Implementation of Graduate Student Project Mentor Training

Based on the results, graduate student involvement can enhance UG skill building, but graduate students need to interact with UG students in a certain way to accomplish this. IBL programs could conduct training for graduate students that teach them what interactions are important in fostering growth such as asking UG students what they want to learn and how to increase frequency of these interaction. These programs could use tools to encourage graduate students to have these specific interactions with UG students. Appendix C offers an example of a tool. The tool helps graduate students foster that conversation about skills and growth, which will then help graduate students encourage growth more effectively.

How to teach 3D printing remotely

A way for graduate students to teach UG students how to 3D print is to take advantage of 3D virtual simulation software that offers a virtual environment for students to practice. An example of this is the CNS Simulator Pro. This software platform allows users to simulate using a 3D printer before running prints on an actual machine and has over forty machines for students to learn 3D printing. The program also offers tutorials and examples for students to use to help them learn 3D printing. Graduate students can work in this program with UG students to help them learn to code using the same machine a UG student would use in person. This software is also free to download from their website. Another online resource with a 3D printing stimulator is MaxWhere, a software company whose mission is to provide 3D printing education virtually to everyone, through their MaxWhere 3D Printing Workshop space. Again, this program simulates every aspect of using a 3D printer, allowing students to engage in the simulation together, where graduate students can teach UG students virtually. These are just two examples of online simulations that teach students 3D printing that can be used to overcome this perceived challenge for online graduate students.

Conclusion

Innovation-based Learning (IBL) programs allow students to collaborate on projects to encourage innovation to tackle real-world problems. In these projects, graduate and undergraduate (UG) students work together, providing an environment for graduate students to transfer knowledge and foster growth in UG students' skills. While this interaction has been supported by research, there is no research analyzing whether online graduate students face challenges that can impede their ability to foster growth in UG students. This study suggests that online graduate students generally do not have obstacles in mentoring UG students in these collaborative projects. Instead, the study suggests that graduate students, as a whole, can foster growth effectively in freshmen but cannot for sophomores and juniors. This difference in promoting growth may be because graduate students interact with freshman students in a way that can encourage growth in skills more effectively based on the perception that freshman students have a weaker engineering skill set than their higher-level class peers. This study displays how IBL programs implement mentor training and provide tools to graduate students to increase the interactions outlined in this paper to make them more effective in fostering growth in UG students at higher class levels. Additionally, since online students generally feel that they do not face any obstacles in mentoring UG students and face no barriers in meeting class standards and expectations, this research encourages higher-education IBL programs not to shy away from incorporating online graduate students into their programs based on ideas that they face challenges that would hinder them from being successful students and mentors. The statistical analyses outlined in this study also shed light on the efficacy of graduate students in fostering growth in UG students engaged in a collaborative project through the IBL teaching paradigm. The analyses provide valuable insight into how IBL programs can tailor graduate students to be more effective in fostering growth for all UG students, not just freshmen.

Limitations

The most significant limitation of this study is that it can have sampling bias since all responses are subjective opinions taken from a small sample. This study exclusively uses thirty-one responses from university students in an IBL Biomedical Engineering program at the same institution, University of North Dakota. These students were recruited across three IBL Anatomy and Physiology for Engineers courses, with 115 students across all three classes. This bias limits the overall understanding of the broader population of UG students and graduate-student interaction in IBL programs. Another limitation is that not all UG students filled out every question in their survey; seven responses included at least one unanswered question. These incomplete surveys may hinder the validity of the data. Lastly, the UG survey did not capture data related to whether the UG students had online or in-person graduate students on their teams. Due to this, the study is unable to make comparisons in perceived growth between UG students mentored by online or in-person graduate students. However, it is important to note that project groups that included both UG and graduate students predominately included at least one online graduate student, with nine out of twelve project teams including at least one online graduate student. This abundance of teams with at least one online graduate student implies that the study sample does encompass UG students who were a part of a team with at least one online graduate student in them.

Future Work

Future work should look to understand whether the above recommendations would make graduate students more effective in fostering growth in UG students at higher class levels. Furthermore, future work will include an analysis of graduate students' perception of UG student skill set, how this perception impacts their interactions with these students, and if this affects growth in skills. Additionally, research should aim to find what interactions between graduate and UG students foster or inhibit growth. Further, future work should confirm or contradict this research by analyzing how effective graduate students promote growth in UG students and the perceived challenges of graduate students across multiple IBL programs to understand these relationships using a broader population. Additionally, it is imperative that these studies collect data regarding if UG students have online or in-person graduate students in their projects. This type of data would be critical in understanding if the graduate student instructional setting impacts graduate students' ability to foster growth.

Further relationships that could also explore how differences in perceived growth in UG students vary depending on majors. This type of work would be valuable in determining if this type of model can be applicable in other engineering programs and not just a Biomedical Engineering program. This type of research would benefit educational institutions that use IBL programs to tailor graduate students, whether online or in person, to be more effective in fostering growth in skills amongst all UG students, no matter the class level.

Disclaimer

This study used Generative AI to analyze open-ended responses from undergraduate (UG) and graduate surveys. Specifically, for the UG survey, questions regarding UG student expectations about the projects and what skills they wanted to gain for participating were uploaded into the text comment box on ChatGPT and analyzed using the prompt "Tell me the top three trends based on this feedback." This study used these same methods to analyze open-ended responses from the graduate survey. Specifically, it was used to analyze questions asking what challenges graduate students perceived from their instructional modality, whether online or in person.

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Appendix A

Undergraduate Survey

1. **What year are you in the program?**
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
2. **On a scale from 1 to 5, with 1 representing minimal growth and 5 indicating significant improvement, how would you evaluate the development of this skill over the semester**.
    a. Sketching and Conceptualizing
    b. Creating Detailed Designs
    c. Utilizing Design Software
    d. Practical Implementation of Design
    e. Coding/Programming
    f. Handling tools and equipment
    g. Utilizing Testing Tools
    h. Speaking Clearly and Coherently during oral presentations
    i. Engaging with an audience during oral presentations
    j. Handling questions and feedback during oral presentations
3. **Briefly describe what your expectations were for your project. What specific outcomes or goals did you hope to achieve?**
4. **Were there any particular aspects of the project (e.g., technical challenges, collaboration, leadership opportunities) that you were especially looking forward to?**
5. **In terms of skills and knowledge, what did you hope to gain from participating in this project?**
6. **Do you believe the project you were involved with will contribute to your academic and professional development?**
    a. Yes
    b. No
7. **Do you have a graduate student on your project team? If so, have they asked you about your confidence in your skills, areas you want to grow in, and what your goals are for the project?**
    a. Yes, I had a graduate student on my project team
    b. No, I did not have a graduate student on my project team
    c. Yes, the graduate student on my team did ask about these questions
    d. No, the graduate student on my team did not ask about these question
8. **Do you think sharing the information you have provided in this survey would help graduate students facilitate improving your skills and reaching your goals? Why or why not?**

9. **On a scale from 1 to 5, with 1 indicating minimal involvement and 5 signifying a high level of involvement, how actively did the graduate student team member on your team participate in your project? (If there were not graduate students on your team select N/A)**
10. **If a graduate student was not on your project team this semester, do you believe that incorporating one in future semesters would substantially enhance the achievement of the overall project goals? (If you did have a graduate team member on your project team this semester select N/A)**
    a. Yes
    b. No
    c. N/A
11. **If you had a graduate student on your project team this semester, do you believe their knowledge, background, and experience significantly contributed to reaching overall project goals? (If you did not have a graduate student on your project team select N/A**).
    a. Yes
    b. No
    c. N/A

Thank you for participating in this survey. Your input is crucial in gaining insights into the undergraduate experience within semester projects

Appendix B

Graduate Survey

1. **Program Assessment:** What Graduate Program are you currently in?
    a. Masters
    b. Ph.D.
2. **Teaching Modality:** Are you currently engaged in a project where you can teach/mentor undergraduate students?
    a. Yes
    b. No
3. **Instructional Setting:** What is your primary instructional setting?
    a. Online
    b. In-person
4. **Teaching/Mentoring Impact:** How does your instructional setting (online or in-person) help or hinder your ability to effectively teach/mentor undergraduate students? (Please elaborate)
5. **Leadership Impact:** How does your current setting (online or in person) impact your role and effectiveness as a graduate student leader? (Consider aspects like communication, collaboration, and mentorship)
6. **Advantages and Opportunities:** In your opinion, what are the advantages or unique opportunities associated with your instructional method (online or in person) in being able to teach/mentor undergraduate students?
7. **Preferred Modality:** Given the option, would you prefer teaching/mentoring undergraduate students through online means, in-person interaction, or a blend of both? Please elaborate on your preference.

Thank you for taking the time to complete this survey. Your input is valuable for understanding the experiences of graduate students in teaching roles and will contribute to improving educational practices.

Appendix C

Tool For Graduate Students to foster a Conversation about Skills and Growth

Section 1: Personal Information

1.1 Program/Major:

1.2 Year of Study:

Section 2: Self-Assessment of Technical Skill

Please rate your confidence level on the following aspects, using a scale from 1 to 5, where 1 is "Not Confident at All" and 5 is "Very Confident."

2.1 Designing Skills:

- Sketching and Conceptualizing:
- Creating Detailed Designs:
- Utilizing Design Software (Specify):

2.2 Building Skills:

- Practical Implementation of Designs:
- Coding/Programming (Specify Languages):
- Handling Tools and Equipment:

2.3 Testing Skills:

- Quality Assurance and Testing Methods:
- Debugging and Troubleshooting:
- Utilizing Testing Tools (Specify):

2.4 Oral Presentation Skills:

- Speaking Clearly and Coherently:
- Engaging with the Audience:
- Handling Questions and Feedback:
-

Section 4: Project Expectations and Growth

4.1 Project Expectations:

4.1.1 Briefly describe your expectations for the upcoming project. What specific outcomes or goals do you hope to achieve?

4.1.2 Are there any aspects of the project (e.g., technical challenges, collaboration, leadership opportunities) that you are especially looking forward to?

4.2 Personal and Professional Growth:

4.2.1 In terms of skills and knowledge, what do you hope to gain from participating in this project?

4.2.2 Are there specific areas (technical or soft skills) in which you would like to see noticeable improvement by the end of the project?