ONLINE MENTORING FOR BIOTECHNOLOGY GRADUATE STUDENTS: AN INDUSTRY-ACADEMIA PARTNERSHIP

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ABSTRACT

The Professional Science Master's Biotechnology program at the University of Maryland University College developed and implemented a novel online mentoring program to increase synergy with the biotechnology industry. In this program, Master's students are paired with mentors from the biotechnology industry. A mentor assistant, who is a graduate of the degree program, assists each pair. Utilizing an open source platform and web-based technologies, each pair interacts on a regular basis to formulate and/or revise the students' professional goals and action plans. Each pair continues their interaction until the student graduates. The impact of the mentoring program is assessed through several measures including feedback on surveys and academic performance. The program grew from 19 mentor-mentee pairs in fall 2009 to 46 pairs in fall 2011. This trend and the current student retention rate of 79% suggest increasing student interest. Among the students who joined the mentoring program, those who continued participating had completed more courses/credit hours at the time of joining than the students who dropped from the program. The end-of-semester questionnaires showed generally positive student satisfaction and provided specific examples of gains in the students' ability to identify and pursue their career goals. The number of courses completed by the mentees was significantly higher than the number of courses completed by a comparison group of non-participants, indicating a possible effect of their participation in the mentoring program. So far, more mentees graduated than the comparison group of non-participants, and in less overall time. As the program progresses, possible effects on students' academic achievement and time-to-graduation will be reevaluated. The effectiveness of the mentoring program on improving the participants' career prospects after graduation will also be examined. The benefit of such a novel program is the ease with which it bridges the gap between industry and academia, providing a remarkable career development opportunity for students while building a strong community of professionals.

KEYWORDS

Mentoring; biotechnology; distance education; industry

I. INTRODUCTION

University of Maryland University College (UMUC) is one of the largest public universities in the U.S. with primarily online degree programs. It serves a diverse student population that is geographically dispersed, and it is one of a handful of universities that offers online Professional Science Master's (PSM) programs (http://sciencemasters.com). PSM programs address the growing need for graduates in the fields of science, technology, engineering and mathematics (STEM). One of the key features of PSM programs is its focus on addressing workforce needs and preparing students with skills desired by employers, which requires a close relationship between these programs and the industry. UMUC is well aware of this

necessity, as illustrated in one of its strategy statements: "Ensure that our academic programs and services are responsive to a changing workforce and a changing world" [1]. In the PSM programs at UMUC close ties are established mainly through advisory boards that comprise industry professionals. Although the need for academia-industry collaborative relationships to enhance student learning and professional development is important in all academic settings, they are even more important for online programs. Most students in online programs are working professionals and adults with competing demands on their time and more likely to suffer from disengagement due to limited professional and community building opportunities [2].

The PSM Biotechnology program at UMUC has a student body of approximately 460 students. The program consists of three specializations in Biotechnology Management, Bioinformatics, and Biosecurity and Biodefense. The degree requires completion of 36 credits (12 courses) as illustrated in Figure 1. The program has grown by 85% in the past five years and the number of graduates has increased by 44%. Students are allowed up to 7 years to complete the degree, but the average time to degree completion is about 3 years. This PSM program fosters a relationship with the industry by integrating a professional skills component in the curriculum. This component, developed in collaboration with the industry, is offered in the capstone course (Figure 1) in the form of a semester long "virtual internship," where students work in teams to complete a project sponsored and supervised by a company [3]. Although these internships allow students to get a closer view into the way the biotechnology industry functions, they typically occur during the last semester or towards the end of the students' studies.

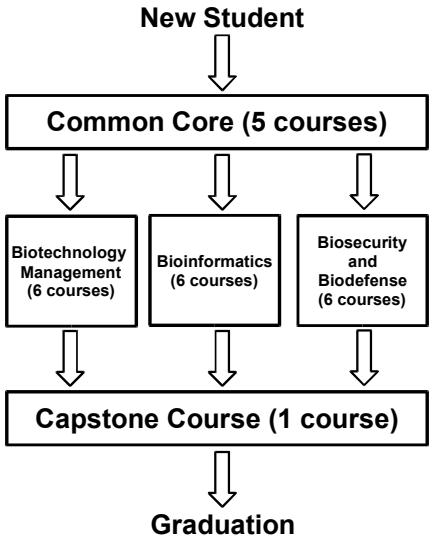


Figure 1: PSM Biotechnology Program Structure showing number of courses and specializations.

Mentoring programs have been offered in academic and professional settings for decades. Research in academia indicates that mentoring has a positive impact on the personal and professional development of students [4]. A growing body of research in higher education also suggests an empirical link between student mentoring and student retention [5, 6]. A research study where students were randomly assigned to either an experimental group which received mentoring, or a control group which did not, showed that mentored students displayed higher retention rates than non-mentored students with similar pre-enrollment characteristics [7]. A more recent study conducted at Stanford University [8] indicates that "coaching" of undergraduate students leads to 13% higher completion rate and 10-15% higher retention rate. All the aforementioned studies were conducted on undergraduate students.

At the graduate level, mentoring has been part of the daily interactions between university faculty or physicians as mentors, and graduate or medical students or postdoctoral fellows as mentees [9, 10]. Programs for training research faculty to become better mentors have been implemented [11], and instruments that assess roles and evaluate perceptions within mentoring relationships have been validated and used in clinical and translational science environments [12]. A recent survey of division chiefs in

Pediatrics [13] indicates that the majority of the chiefs had dyadic (senior to junior) mentoring relationships and believed that mentoring would be beneficial to their faculty. In summary, the consensus of published studies indicates that mentoring is beneficial to students.

Meta-analysis of literature has examined the effectiveness of mentoring in academic environments and in the workplace. Specifically, Eby et al found that although there is some association between mentoring and career attitudes (e.g., career expectations or perceived employment opportunity), the effect size was small [14]. Ingersoll and Strong critically evaluated 15 empirical studies looking at the effect of mentoring on three outcomes among new teachers: retention, classroom practices and student achievement [15]. The majority of the studies showed a positive impact of induction, which includes mentoring as a major component, on all three outcomes. Finally, in another study focusing on corporate mentoring programs, the effect size of mentoring on career outcomes was found to be significant [16].

Online mentoring programs are not as common as traditional ones. Examples of current online mentoring programs include (1) Mentornet, a non-profit organization that pairs students from participating colleges with science and engineering professionals (www.mentornet.net); and (2) Lifeworks E-mentoring, which is run by the National Institutes of Health, Office of Science Education, and pairs high school or college students with professionals in the biomedical or healthcare industry (science-education.nih.gov/LifeWorks/Ementoring).

In the fall of 2009 the PSM Biotechnology program at UMUC launched an online professional mentoring program as a student support service to address two goals:

1. develop closer and more sustained ties with the biotechnology industry, and
2. create a nurturing and professional development community for its geographically dispersed students.

This program provides students in the online Biotechnology Master's program the opportunity to work closely with mentors from the industry. The mentors assist students in exploring realistic career goals, developing an awareness of workforce needs and advances in the biotechnology industry, and acquiring skills for a successful career. As a consequence of this interaction the mentoring program is expected to enhance the learning experiences and marketability of our diverse student population.

This paper discusses the UMUC biotechnology online mentoring model; the program's development and implementation; its impact on student professional development and academic performance; as well as challenges and future directions.

II. BIOTECHNOLOGY PROFESSIONAL MENTORING PROGRAM DESCRIPTION

A. Mentoring Model

In this novel online mentoring model, each mentee, who is a student in the biotechnology degree program, is paired with a volunteer mentor, who is a biotechnology professional from the industry, government or academia.

The following key features set this model apart from other mentoring programs:

1. It is offered at the graduate level and it is embedded in the degree program.
2. It has participants who are geographically dispersed. It utilizes web-based technologies to enable flexibility in participation and management of resources.
3. It is potentially sustainable through the participation of program graduates as mentors.
4. It provides a mentor assistant (MA) for each pair of mentor-mentee, to facilitate and monitor their interaction, and to ensure that any questions or issues are addressed promptly.

The last key feature is a unique aspect of this model because MAs are involved in every step of the program implementation, from student selection to successful interaction between the pairs until the student's graduation.

As an added advantage, this mentoring program advances the university's relationship with the biotechnology industry, and provides an opportunity for the industry to shape future employees by directly advising students and providing feedback on the curriculum.

B. Platform for Mentoring Program Interaction

The mentoring model and platform were designed and developed over a period of one year. The Advisory Board for the UMUC PSM programs provided recommendations on the requirements for the mentoring platform. Claroline, an open-source learning management system, was identified as the best fit for our needs, namely because: (i) it was free of charge, (ii) the backend programming language was known to in-house technical support which allowed easy customization, (iii) it provided an area for collaboration, and an area for sharing documents, (iv) it allowed private groups to be set up for each mentor-mentee-mentor assistant threesome, (v) it included a calendar, and (vi) it offered a video conferencing feature.

Over the same year, documents that were considered essential for the program were developed, including application forms for all three types of participants, marketing materials for advertising the program and recruiting mentors, end-of-semester assessment forms for the participants, and the professional action plan (PAP) forms for the students. Since the program's launch, other documents including tips for getting the most out of a mentoring relationship and expectations for mentees and mentors have also been developed. For example, the "tips" document for mentees advises them to be responsible, to remember that the burden of the relationship is on them, and to be reliable and prepared. Suggested "tips" for mentors include being a good listener, asking questions to guide the student, and providing support and alternatives to students' current goals. The expectations for the mentees include being proactive, listening and following through to the mentor's suggestions, and being prepared for the meetings. The expectations for the mentors include guiding their mentees in clarifying their short and long term goals, and meeting with them regularly.

The online interaction platform (http://psmmentoring.umuc.edu) was customized to have two areas. The public area provides information on the mentoring program; a description of benefits and responsibilities for mentors and mentees; application forms; the grant proposal and other background information. The private area, which requires login, includes (a) classrooms for each mentor-student pair, where they are able to chat, send emails, share documents, or have audio/video conferencing with each other; (b) common areas for all participants where they can share experiences and tips; and (c) an online component for data collection (end-of-semester questionnaires).

C. Participants' Selection and the Mentoring Process

1. Selection of Participants

Graduate students who are within the first 18 credits (6 courses) of the Biotechnology program are invited to apply to the mentoring program every fall and spring semester. This upper limit of 6 courses completed before joining the mentoring program was imposed so that students can participate for at least 2-3 semesters while they are completing a minimum of 6 remaining courses (Figure 1). The selection criteria include writing skill, articulation of reasons why students are pursuing the biotechnology degree, and justification for what makes them an appropriate candidate for the mentoring program. Grades and academic performance are not part of the selection criteria. These student selection criteria were designed to give every student, irrespective of their academic performance, a chance to apply and be selected for the mentoring program. Since the online nature of the program would necessitate substantial communication with the mentor, either via email or phone, it was decided to use oral and written communication skills as criteria. Considering that all the mentors in the program are volunteers, it was important to pick students who were genuinely interested in this support service and were going to make the most of it. Each application is screened and scored by two MAs based on a rubric. Those who meet the preset cutoff score are invited for a phone interview with the MAs, which is the final step in the selection process.

To recruit mentors, the program was publicized through several avenues. Typically, mentors are recruited through personal contacts, announcements made on social media sites or in newsletters and intranets of professional organizations.

The project director selects the MAs from a pool of degree program graduates, based on their availability, continued interest and involvement in the degree program, and a strong belief in the positive impact of mentoring.

2. Mentor-Mentee Interaction Process

Students are paired with mentors based primarily on shared interests, including specialization, and secondarily on common location. Each pair is assigned a MA whose role, as mentioned before, is to facilitate the interaction and support their efforts in sustaining a productive relationship. Each MA is responsible for approximately 10 mentor-mentee pairs.

All new participants are required to attend orientation sessions conducted by MAs and held separately for mentors and mentees. During these sessions, the participants are provided with details on what they should expect from the program and what is expected from them, as well as a description of the logistics involved. For example, mentees are explicitly told that they cannot ask their mentor for a job. However, they are encouraged to learn about the tools that would enable them to achieve their career goals.

Prior to the first mentee-mentor meeting, each MA asks the mentees in his/her group to complete a professional action plan (PAP) that outlines their goals along with action items for achieving each goal. Brief bios are requested from the mentors, and for each pair the bio and the PAP are exchanged between the mentor and their mentee. During the first meeting the mentor provides comments and suggestions on the PAP, and the two follow up in their next meeting. The mentees keep a log of what is being discussed so that they can easily follow-up on the previous meeting's discussion. The MAs contact the participants at least bi-monthly to find out if there is anything they can do to help facilitate the interaction. For example, they check with each member to identify any questions or concerns they may have. If a mentee is unsure of what to discuss with the mentor, the MAs offer guidance and suggest topics. Alternatively, if a mentor needs more guidance on how to better help a student, the MAs may give them ideas such as setting milestones and documenting action items.

All participants are expected to meet with their counterpart at least once a month. Although the program provides the online platform to facilitate interaction, there are no limitations on the mode of communication. Most mentor-mentee discussions take place over email, chat, video-conferencing or phone, with occasional face-to-face meetings, if both participants are in the same geographical area.

3. A Self Sufficient program

An important goal of the program is sustainability, meaning that the program is able to continue for a long time with little additional financial or time resources. The most time consuming parts of the program are the student selection process and the recruitment of mentors. The former can be made more efficient by automating certain parts but will still require substantive time commitment. The latter can be made self-sustainable through participation of biotechnology program alumni as mentors and mentor assistants. In addition to recruiting mentors from the industry, over time, students who graduate after participating in the mentoring program and are employed in the industry will be invited to join as mentors or mentor assistants, as illustrated in the sustainability model of Figure 2.

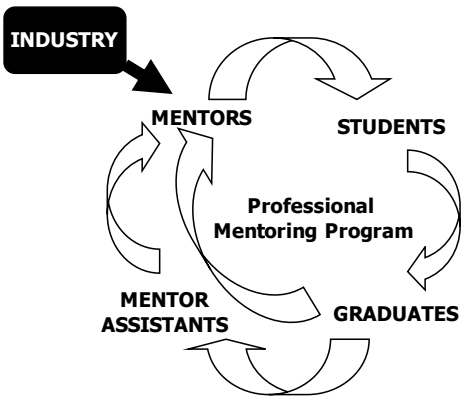


Figure 2: Sustainability model for the Mentoring Program.

4. Profile of current participants (Fall 2011)

In fall 2011, 46 students were paired with 42 mentors. Four mentors had 2 mentees each.

The group of mentees was almost evenly divided among the three specializations: biotechnology management (30%), bioinformatics (33%), and biodefense (37%). Additionally:

- 85% were employed
- 72% had a background in life sciences
- 48% live within the Washington DC metropolitan area
- 56% are female
- 45% are African American, Asian, or Hispanic (13% unknown)

The mentees are in different stages of their academic studies: some have just joined the degree program, and some have had several semesters of study.

Most of the mentors had a background in biotechnology management (74%), as opposed to the other two specializations: bioinformatics (21%) and biodefense (5%). This mismatch between student specialization and mentor background does not appear to present a problem, as mentors are not expected to give guidance that relate exactly to their own job description, but rather a more comprehensive view of the industry. Additionally:

67% work in the private industry; 14% in academia; 14% in government; and 5% are self-employed.

64% work within the DC metropolitan area

41% are female

It is important to note that a high percentage of the students and the mentors do not live in the metropolitan DC area and so it is essential that the mentoring program can be effective in an online format.

As noted earlier, an effort is made to pair students with mentors in the same specialization and the same location; however, due to the variability of student applicants and mentor volunteers this is not always possible. So far, end-of-semester questionnaires indicate that the mentors who work within a different specialization or in a different state than the mentee are still able to offer assistance with goal clarification, networking opportunities, and better understanding of the biotechnology industry.

III. MENTORING PROGRAM IMPACT

To measure the impact of this novel, online mentoring program we looked at both tangible and intangible factors. The tangible factors include the growth of the program, retention in the program, and student academic performance. Intangible factors include gains in the students' ability to identify and pursue their career goals as documented in testimonials and in participants' responses to survey questions.

A. Program Growth

The mentoring program was launched in fall 2009 with 19 pairs of mentors-mentees. Each subsequent semester, more students join the mentoring program, and several of the existing mentees continue to participate (Table 1). For example, in fall 2011, the mentoring program grew to 46 pairs: 33 mentees continued from the previous semester and 13 new mentees joined the program.

Semester	Total number of mentees	Number of continuing mentees	Number of new mentees
Fall 2009	19	NA	19
Spring 2010	31	15	16
Fall 2010	41	23	18
Spring 2011	45	31	14
Fall 2011	46	33	13

Table 1: Program participation for each semester of implementation: total number of mentees, number of mentees who are continuing from the previous semester, and number of new mentees.

Each semester, the number of available mentors limits the number of students that can be accommodated. However, consistent with the goal of the mentoring program to offer this service to as many students as possible, the majority of student applicants have been accepted.

B. Retention in the mentoring program

It is expected that students who join the mentoring program will continue to participate until they graduate from the degree program. By the end of the fall 2011 semester a total of 9 students had graduated. Some students left the program in their second or third semester. The most common reason provided was time limitations due to personal or professional responsibilities or leaving the degree program due to financial constraints. Figure 3 shows the retention rates in the mentoring program between semesters.

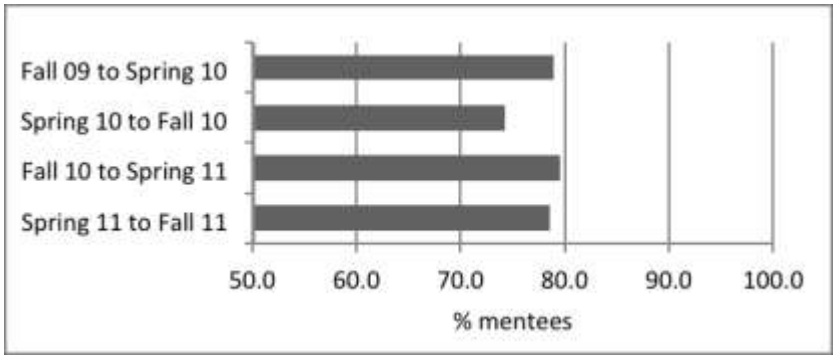


Figure 3: Student retention in the mentoring program across semesters.

We examined whether retention in the mentoring program is affected by (a) the number of courses mentees had completed before joining the mentoring program or (b) the age of the mentees. Due to the small number of participants, we used non-parametric statistics. Our findings from the non-parametric Mann-Whitney tests indicate that:

(a) The mentees who either graduated before fall 2011 or continued in the program from spring 2011 to fall 2011 (n=38) had completed a significantly higher number of courses before joining (Mdn=4) than the mentees who dropped out after at least one semester (n=30, Mdn=2.5) ($p<.05$).

(b) The age difference between the mentees who continued in the program (Mdn=32) and the mentees who dropped out (Mdn=30) is not statistically significant ($p=.055$).

The above data indicate that the students, who are further along in their studies when joining the mentoring program, tend to continue their participation after at least one semester.

C. Academic performance

Institutional data on student grades and demographic information were collected to look for any effects on academic performance and possible trends within subgroups.

1. Comparing fall 2011 participants to non-participants

In order to compare the mentees' academic performance to the academic performance of non-participants, we selected a comparison group from their peers in the degree program that matches the mentees in certain characteristics. Each mentee was "matched" to a non-participating student based on: (1) specialization, (2) semester when they joined the degree program, and (3) number of courses and grades up to the semester before the mentee joined the mentoring program. Another requirement was that both the mentee and the non-participating student signed-up for classes during the semester that the mentee joined the mentoring program. Based on these criteria, the best match is included in the comparison group. Specialization was a perfect match for all mentees, but that was not always true for the other two variables. For example, a student who begun her studies in summer 2008 was matched to a student who begun her studies in fall 2009. Finally, 5 students had taken no classes before joining the mentoring program, and so they were matched to non-participants who had taken no classes at the time.

We examined two variables relating to students' academic performance:

- For all participants (n=46), total number of classes completed by the end of fall 2011.
- For all participants (n=46), GPA at the end of fall 2011.

These variables are non-normally distributed therefore we used non-parametric statistics, specifically the Wilcoxon Signed-ranks test, to find out if there is a significant difference between the participants and the comparison group. Due to the small size of the mentoring program we consider all values of $p<0.05$ to be significant. The effect size r for the Wilcoxon signed ranks tests is calculated as $z/\sqrt{N}$, where Z is the z-score and N is the total number of observations, in this case the total number of participants and non-participants in each comparison [17].

Wilcoxon Signed-ranks tests indicated that:

- The GPA of the participants at the end of Fall 2011 (*Mdn*=3.55) was *not* significantly higher than the GPA of the non-participants (*Mdn*=3.46): Z=1.44, p=.075.
- The participants completed more classes by the end of Fall 2011 (*Mdn*=8), than the comparison group of non-participants (*Mdn*=7), Z=2.44, p=.007, r = .26.

The difference in number of courses completed still holds when limiting the sample to students who completed at least one class before joining the program (n=41), and comparing the number of courses after joining the program: these mentees completed more classes after joining the program (Mdn=4) than their non-participating counterparts (Mdn=2): Z=2.77, p=.017, r =.23.

Based on Cohen's guidelines (18, 19, 20], the above effect sizes (r) represent a small to medium effect of the mentoring program participation on the number of courses completed (i.e., they are below Cohen's benchmark of .3).

The above data indicate that students, who participated in the mentoring program, completed a significantly higher number of courses compared to their counterparts in the same time period, but they did not have significantly higher GPAs.

This suggests that students who choose to participate in the mentoring program may be more dedicated in completing their courses, or that interaction with their mentor is a factor in giving them the encouragement to complete courses at a faster pace than their counterparts.

Due to the small sample size, we do not consider these results conclusive, but rather an indication of a possible positive effect of mentoring program participation on course completion. Academic achievement

data will be re-examined at the end of each subsequent semester.

2. Trends among participants

To examine whether there are any trends in academic performance among the participants, we performed non-parametric tests for different subgroups. The Kruskal-Wallis test showed no significant difference between the three student specializations in terms of number of courses completed or average student GPA. Similarly the Mann-Whitney test showed no difference in the above measures for students of different gender, employment status, or background in life science. The same holds true for ethnicity, when looking at differences between Caucasians and non-Caucasians. Based on these results, no subgroups of participants appear to be benefiting more than others, in terms of their academic performance.

3. Semesters to graduation

As noted earlier, students are accepted in the mentoring program at different stages of their studies, and therefore they have different degree program completion timelines. So far, more mentees graduated from the degree program and in less overall time than the comparison group of non-participants.

Nine mentees graduated from the degree program by the end of fall 2011. These students studied between 3 and 9 semesters (Mdn=6). In contrast, only 4 students from the comparison group graduated, completing their studies within a range of 5 to 10 semesters (Mdn=7). Currently the number of graduates is too small to examine whether there is an effect of the mentoring program on time-to-graduation, therefore these variables will be reexamined as more students graduate.

D. Participants' feedback

1. End-of-semester questionnaires

All participants are invited to provide their feedback through end-of-semester questionnaires. The mentee questionnaire is provided as a sample (Appendix A). These questionnaires aim to gather information on (a) number of contacts between each mentor and mentee; (b) the content and actions as an outcome from their discussions; (c) satisfaction with the program; (d) suggestions for improvement; and (e) suggestions for curriculum changes for better alignment with the industry needs. Feedback from the participants is regularly reviewed and suggestions for improvement are considered for implementation before the start of the next round of new applicants. The response rates to these questionnaires were as shown in Table 2.

Respondents for each semester	Number (%) mentees	Number (%) mentors
Fall 2009	19 (100%)	15 (79%)
Spring 2010	25 (81%)	20 (65%)
Fall 2010	29 (71%)	22 (54%)
Spring 2011	34 (76%)	32 (71%)
Fall 2011	21 (43%)	16 (36%)

Table 2: Number and percentage of participants who responded to the questionnaires each semester.

As part of the questionnaires, the participants were asked to indicate their level of agreement with certain statements on a six-level sliding scale: strongly disagree; disagree; slightly disagree; slightly agree; agree; strongly agree (Berk et al., 2005). Listed below are sample statements from these questionnaires for mentors (a) and mentees (b). Figure 4 shows the median responses to these statements from mentors (top) and mentees (bottom) for four semesters: spring 2010 to fall 2011.

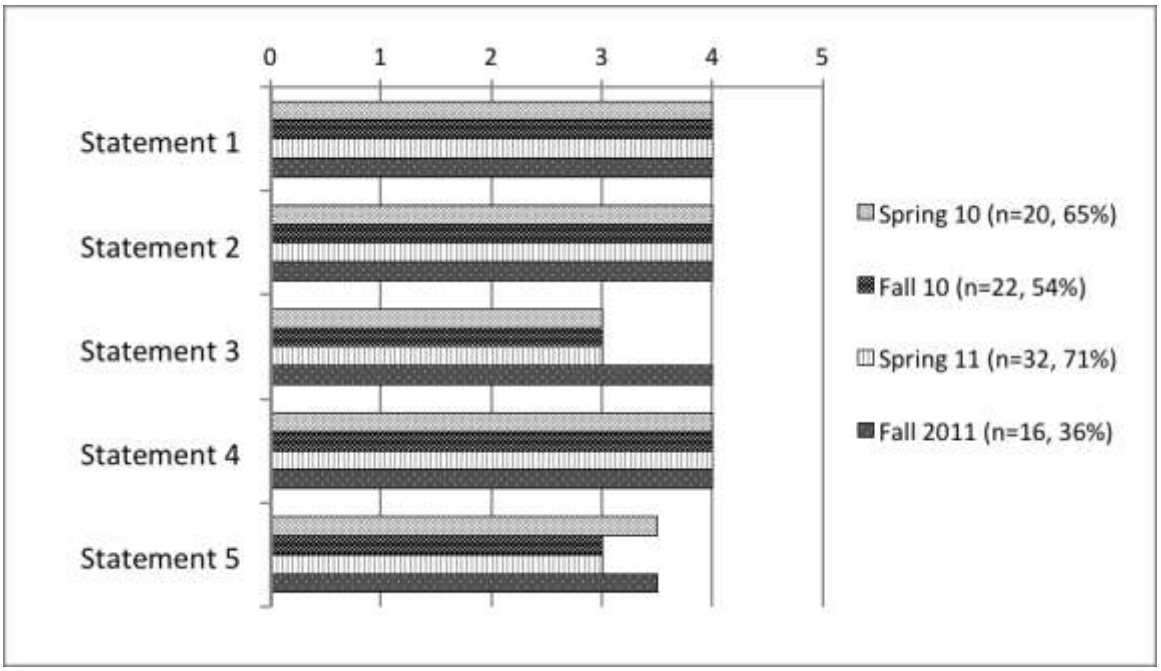
a. For Mentors:

- Statement 1. My mentee is eager to learn and utilize the career guidance I provide.
- Statement 2. With my assistance, my mentee set short-term goals and is working through them.
- Statement 3. With my assistance, my mentee developed a long-term plan for career development or career change.
- Statement 4: I challenged my mentee to extend his/her abilities (e.g., try a new professional activity; draft a section of an article).
- Statement 5: My mentee has begun taking advantage of networking opportunities.

b. For Mentees:

- Statement 1. My mentor is supportive and encouraging.
- Statement 2. My mentor is helping me set short-term goals and work through them.
- Statement 3. My mentor is helping me develop a long-term plan for career development or career change.
- Statement 4: My mentor challenges me to extend my abilities (e.g., try a new professional activity; draft a section of an article).
- Statement 5: My mentor facilitates networking opportunities in my field of interest.

c. Mentors



d. Mentees

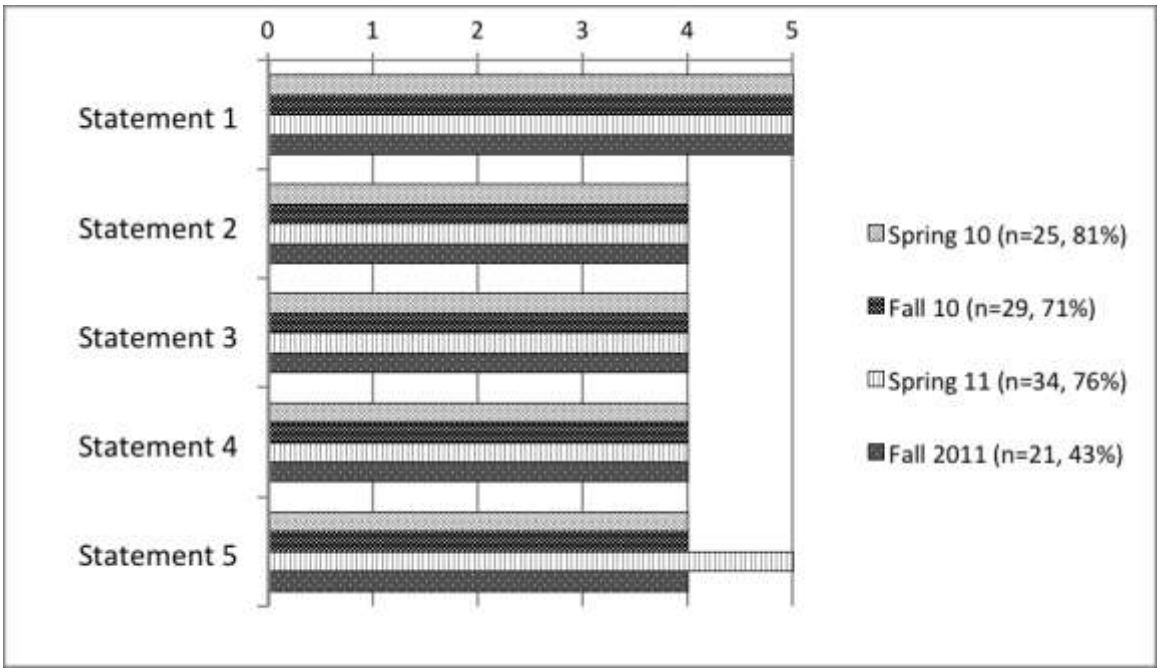


Figure 4: Median mentor (a) and mentee (b) responses to a sample of provided statements, at the end of four semesters. Strongly Agree=5; Agree=4; Slightly Agree=3; Slightly Disagree=2; Disagree=1; Strongly Disagree=0.

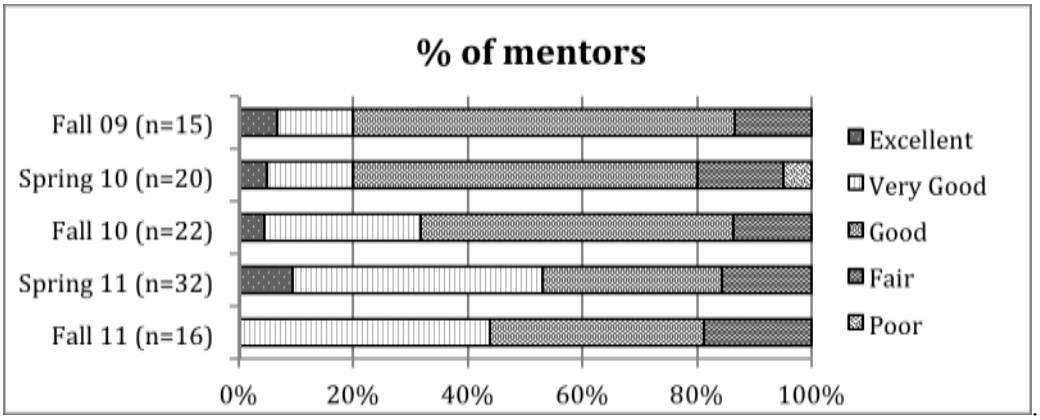
In order to assess what is gained from the program, both mentors and mentees were asked to support their selections with specific examples of actions the mentees took as a result of their interaction with their mentors. Most common actions taken by mentees include

- Taking advantage of networking opportunities (e.g., attending conferences or contacting other professionals in the mentor's network)
- Revising their resumes to better target job opportunities
- Gaining in depth knowledge about their fields of interest
- Focusing in on their goals and on how their studies would translate in the workplace
- Exploring publication opportunities

For example, one student wrote: "I didn't realize that having access to a senior biotech executive would help me further define and restructure my life goals. This experience has been exceptional in regards to helping me with networking, communication, educational, career, and life skills. I was able to utilize all of this, along with resume building and interview advice, to improve my outlook and advance within my desired career field."

As part of the end-of-semester questionnaires, mentors and mentees were asked to rate the program on a five-level scale (Poor to Excellent) at the end of each semester (Figure 5). Throughout the five semesters, the mentee ratings appear to be more favorable than the mentor ratings. Based on Mann-Whitney non-parametric tests, the difference in ratings between mentors and mentees is statistically significant for each semester ($p<.05$). There was no statistically significant difference between the ratings of new participants and those who participated for multiple semesters.

e. Mentors



f. Mentees

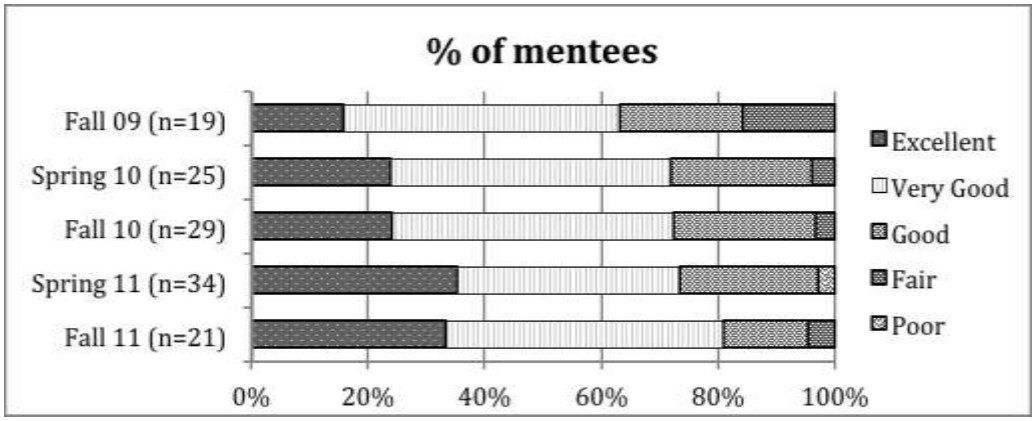


Figure 5: Program rating by mentors (a) and mentees (b) at the end of 5 semesters (fall 2009 – fall 2011). The results are shown as % of participants for each rating level.

Based on the same end-of-semester questionnaires, it appears that the participants are satisfied with the program's flexibility and the availability of support. However, it became apparent that some pairs were able to thrive and progress on their own, with very little support from the program, while some other pairs at some point, found themselves at a loss on how to continue a productive interaction. For that reason, the program made available a list of suggested discussion topics, and mentor assistants are making an effort to better facilitate their interaction.

2. Follow-up after graduation

To examine whether participation in the mentoring program has an effect on students' career paths after graduation, we sent follow-up questionnaires (Appendix B) to the 9 students who graduated. 7 students responded: 6 of the 7 students are still in touch with their mentor (3-18 months after graduation) and all 7 students expressed interest in joining the program as mentors.

One of 7 students credits the mentoring program for being instrumental in her attaining work because it helped the student articulate the job resume, perfect the job search, and prepare for interviews, and network. Six of the 7 students were already employed and they did not mention any direct effects of the mentoring program participation on their careers (e.g. promotion or new job). Three of these six students credit the mentoring program for helping them focus on and solidify career goals; providing a better understanding of job possibilities within a certain specialty; and allowing networking to prepare for future opportunities.

IV. SUGGESTED AND/OR IMPLEMENTED CHANGES

Since the implementation of the program in 2009, the end-of-semester questionnaires have been reviewed and modified to better phrase some questions in order to glean more useful information that would assist in the improvement of the program. In response to the participants' request for more direction and clarification of the program goals, we took the following steps:

- A comprehensive orientation session for new and continuing mentees was developed.
- The format of the mentor orientation was modified to emphasize and clarify expectations.
- A document "10 tips to maximize your mentoring experience" was prepared and made available on the platform.
- Group meetings among mentees or among mentees and mentors are organized twice each semester in order to exchange ideas and suggestions with each other.
- "Community classrooms" for all mentees, all mentors, and each specialization were created on the program website.
- An annual symposium "Careers and Trends in Biotechnology" is organized to facilitate networking interactions between students, faculty, and industry professionals.

Based on mentors' suggestions, the program is also considering online networking events via video-conferencing platforms.

Even with these available resources, close monitoring of each pair by the MAs is required to ensure that the mentoring relationship grows and strengthens. Sometimes these relationships do not work, even if the match appeared to be perfect on paper. For this reason, the MAs are encouraged to ask students after one or two semesters if they want to continue with the same mentor. The participants also have the opportunity to express pairing concerns on the end-of-semester questionnaires. As a result of such concerns, 5 students and 8 mentors have been re-assigned since the launch of the program.

V. CHALLENGES AND SOLUTIONS

As with any new program this one has not been without challenges. Some of the issues have been addressed, while others are work in progress.

One of the challenges is the relatively low number of student applicants. This is being addressed by asking existing participants to share their experiences and by making more announcements about the mentoring program in the classroom.

Another challenge early on was that students were selected based only on their application, and in several instances, the selected candidate turned out to be completely lacking in motivation. Therefore, starting with the second semester of the launch, a phone interview was added to the selection process.

The challenge of making the right "match" is still present but to a much lesser extent. In the first few semesters the pairings were made largely based on what the applicants said in their applications, which resulted in a few incompatible pairings. In subsequent semesters the interview questions were modified to get a better understanding of what the student was looking for, and that was also used as a factor in making pairings. In some cases it was found that making a match based on the area of interest of the mentor and the mentee was not necessary because the mentee was looking for general advice.

Despite having the mentees fill out the PAP and go through the orientation, some participants continue to ask for help in engaging in a conversation with their mentor/mentee. The MAs monitor the pairs more closely to be able to address any potential issue. Phone conferences with all participants are now organized once per semester. During these conferences, a couple of senior and junior pairs are asked to share their experiences with the rest of the group.

Increasing the number of mentors who are UMUC alumni (currently 14%) is a continuing challenge. As mentees graduate from the degree program, they will be invited to join as mentors, in order to improve

program sustainability.

VI. FUTURE PLANS

The current focus is to make the selection process more efficient through developing web-based applications and databases that will speed up the student screening process and ease the data collection procedures. This automation should result in a more expeditious sorting and analysis of data, and help with the scalability of the program.

In an attempt to provide an opportunity for other universities to adopt/adapt this mentoring model, information about the program is disseminated through informal talks and presentations at national and international conferences. All the documents that we developed (including selection process protocols, expectations and tips for participants, and end-of-semester questionnaires) can be made available to interested parties.

The ultimate goal of the program is to improve students' career opportunities. Therefore follow-up questionnaires from students who graduated from the degree program will continue to be collected every semester, in order to examine whether the mentoring experience affected their career paths, directly or indirectly.

VII. RESOURCES TO DEVELOP A MENTORING PROGRAM

In our experience, the most used resource for this program has been time. There were three full time UMUC employees who devoted 10-15% of their time towards the project in the first year. After the first year, the project director and one other full-time employee continued dedicating the same amount of time to the program. There was a one-time cost for a programming expert to customize the platform and develop the databases. An external evaluator was the other contractual employee hired every year to collect and analyze the data. Other recurring costs include the stipends paid to the four mentor assistants every fall and spring semester and the annual platform hosting server fee. The use of open source resources eliminated any cost to buy a commercial platform. All marketing materials (mentor recruiting and program promotion flyers) were prepared by UMUC's Marketing Department at no cost.

Disseminating this mentoring model to other programs and institutions is an important aspect of this program; therefore all developed materials are made accessible to interested parties. In fall 2010, the Master of Arts in Teaching program at UMUC adapted this mentoring program. Another program at the University of Tennessee Law School used select parts of our model and materials to develop their own program.

VIII. SUMMARY / CONCLUSIONS

A novel and viable online mentoring program was developed and offered to master's students in the UMUC PSM program in Biotechnology. The program is novel because of its simplicity, ease of dissemination and scalability. Two of its key strengths are the low cost of offering such a program and the high potential for sustainability because of the involvement of program alumni. Quantitative and qualitative measures used to assess the program's impact on students suggest that although academic performance of student participants is not greatly enhanced, their professional growth is positively affected, as indicated in surveys. Through the first five semesters since its implementation, the program grew to more than double its original size indicating growing interest and increasing visibility. In fall 2011 79% of the mentees from the previous semester continued in the mentoring program. Current data indicate a probable positive correlation between retention in the mentoring program and the number of courses students have completed before joining the mentoring program. This suggests that it may be important for students to complete at least one semester of studies in the degree program before they are able to engage fully in interacting with their mentors. If this observation holds in subsequent semesters, a minimum number of credits will be required for students to enter the mentoring program.

Academic achievement was not a factor in mentee selection. However, the statistically significant difference between the numbers of courses completed by the mentees vs. the comparison group, and the small effect size, suggest that mentoring program participation may have a positive effect on the rate of course completion. Additionally, more mentees than comparison group non-participants have graduated so far, and in less time since the start of their studies. Another interpretation of these results could be that the students who join the mentoring program are already determined to complete their degree at a fast pace. Therefore, the above analyses are considered to be indications of a possible positive effect of student participation in the mentoring program on student degree completion, and these trends will be reexamined in subsequent semesters.

According to end-of-semester questionnaires, the participants indicate that their interaction with their mentors lead to (a) improved understanding of the biotechnology industry; (b) clarification and focus on their personal career goals, and (c) greater initiative in pursuing networking opportunities.

Although the program's potential impact on students' job prospects is still to be determined, current data indicate that the majority of mentees are satisfied with their mentors' assistance in defining and pursuing their short term and long term goals. The program was consistently rated high by all the participants but more so by mentees. This could be due to the mentees seeing a more direct effect on their knowledge, skills, and attitudes than the mentors do, and therefore rating the program higher. It should also be noted, that the selection criteria for student participation in the mentoring program are based on the students' ability and willingness to participate fully. This may have a positive effect on the student ratings, in that mentees are willing participants and appreciative of what they can gain from the program.

The small number of graduates who responded to follow-up questionnaires indicated similar gains. As the number of graduates increases in the next year, a better understanding of the effect of mentoring program participation on the students' careers is expected.

The information presented in this paper indicates that the impact of such a program is greater on intangible outcomes as it provides students with tools that may serve them well in the long run. Both graduates and current participants find the program invaluable in preparing them for obtaining their desired career in the biotechnology field.

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University of Maryland, College Park.

Dr. Arhonda Gogos is the Evaluator of projects implemented at the Biotechnology Program and the Master of Arts in Teaching Program of the University of Maryland University College: (1) an online mentoring program that pairs students with biotechnology industry professionals; (2) a tiered mentoring program for current and future Arts and Sciences teachers; (3) a program for the improvement of English and writing skills for Hispanic graduate students She also serves as a Course Manager, overseeing more than 20 online classrooms, monitoring the instructors' engagement, and providing feedback on ways to improve their performance. As a Research Associate at the American Association for the Advancement of Science, Project 2061, she worked on the clarification of science learning goals, identification of student misconceptions, and development and evaluation of science assessment items. Dr. Gogos has extensive research experience in the Biotechnology industry, with expertise in methods for structure-based drug design. She received a Ph.D. in Biophysics from the Johns Hopkins University.

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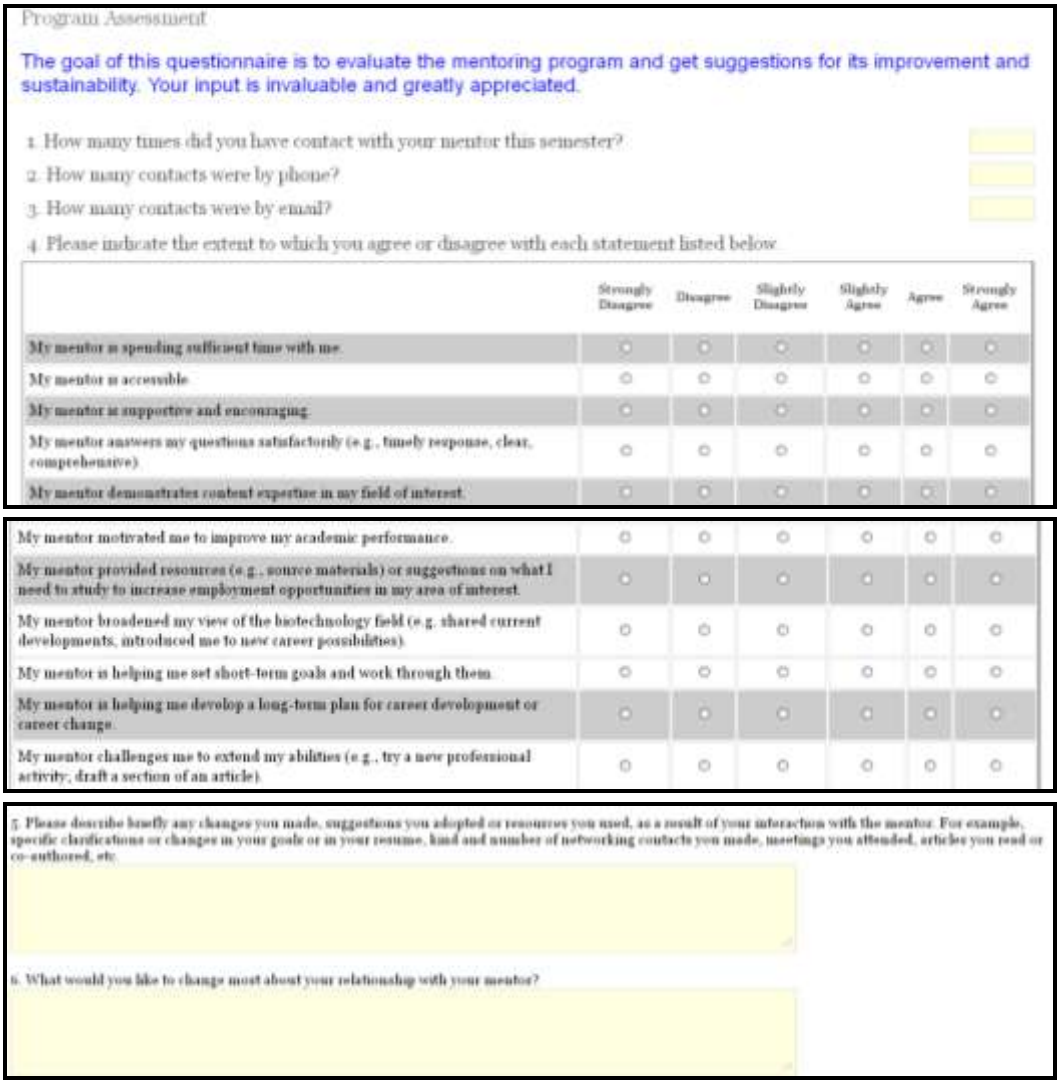
XII. APPENDIX A

END OF SEMESTER QUESTIONNAIRE FOR STUDENTS



Program Assessment

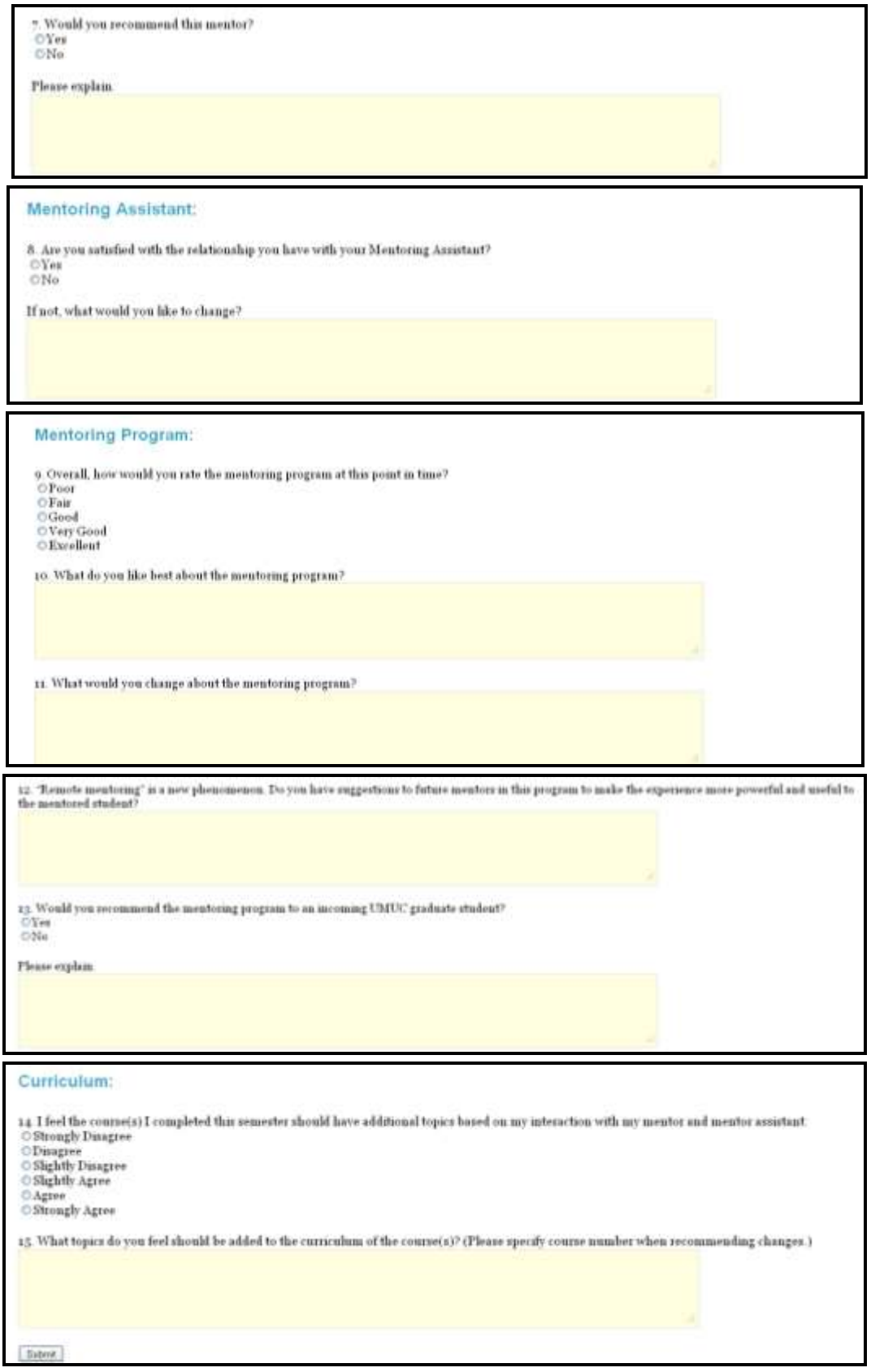
The goal of this questionnaire is to evaluate the mentoring program and get suggestions for its improvement and sustainability. Your input is invaluable and greatly appreciated.

1. How many times did you have contact with your mentor this semester?
2. How many contacts were by phone?
3. How many contacts were by email?
4. Please indicate the extent to which you agree or disagree with each statement listed below

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
My mentor is spending sufficient time with me.	○	○	○	○	○	○
My mentor is accessible.	○	○	○	○	○	○
My mentor is supportive and encouraging.	○	○	○	○	○	○
My mentor answers my questions satisfactorily (e.g., timely response, clear, comprehensive).	○	○	○	○	○	○
My mentor demonstrates content expertise in my field of interest.	○	○	○	○	○	○
My mentor motivated me to improve my academic performance.	○	○	○	○	○	○
My mentor provided resources (e.g., source materials) or suggestions on what I need to study to increase employment opportunities in my area of interest.	○	○	○	○	○	○
My mentor broadened my view of the biotechnology field (e.g. shared current developments, introduced me to new career possibilities).	○	○	○	○	○	○
My mentor is helping me set short-term goals and work through them.	○	○	○	○	○	○
My mentor is helping me develop a long-term plan for career development or career change.	○	○	○	○	○	○
My mentor challenges me to extend my abilities (e.g., try a new professional activity; draft a section of an article).	○	○	○	○	○	○

5. Please describe briefly any changes you made, suggestions you adopted or resources you used, as a result of your interaction with the mentor. For example, specific clarifications or changes in your goals or in your resume, kind and number of networking contacts you made, meetings you attended, articles you read or co-authored, etc.

6. What would you like to change most about your relationship with your mentor?



7. Would you recommend this mentor?
○Yes
○No

Please explain

Mentoring Assistant:

8. Are you satisfied with the relationship you have with your Mentoring Assistant?
○Yes
○No

If not, what would you like to change?

Mentoring Program:

9. Overall, how would you rate the mentoring program at this point in time?
○Poor
○Fair
○Good
○Very Good
○Excellent

10. What do you like best about the mentoring program?

11. What would you change about the mentoring program?

12. "Remote mentoring" is a new phenomenon. Do you have suggestions to future mentors in this program to make the experience more powerful and useful to the mentored student?

13. Would you recommend the mentoring program to an incoming UMUC graduate student?
○Yes
○No

Please explain

Curriculum:

14. I feel the course(s) I completed this semester should have additional topics based on my interaction with my mentor and mentor assistant.
○Strongly Disagree
○Disagree
○Slightly Disagree
○Slightly Agree
○Agree
○Strongly Agree

15. What topics do you feel should be added to the curriculum of the course(s)? (Please specify course number when recommending changes.)

Submit

XIII. APPENDIX B

Follow-up questionnaire for students who graduated from the degree program while participating in the mentoring program. This is sent individually to each student via email.

1. Are you still in touch with your mentor?
2. Were you employed at the time you joined the mentoring program? If yes, then did the mentoring program assist you in getting more responsibilities or a promotion or in any other way?
3. If you were not working at the time you joined the mentoring program, how did the participation prepare you to e.g. solidify your career goals, get a good job, use networking to seek employment opportunities or in any other way?
4. Would you like to serve as a mentor, either now or in the future?