

Mentorship in Undergraduate Biomedical Education: Identifying Student Opinions and Expectations

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ABSTRACT

OBJECTIVE: To evaluate undergraduate biomedical education student opinions and expectations on mentorship.

METHODS: A survey was administered to students enrolled in the undergraduate biology, neuroscience and nursing programs at a large public research-intensive university. The survey queried demographics, previous mentorship experiences, ideal qualities of mentors, benefits/value of mentorship and future plans for seeking mentorship. Survey responses were evaluated using either t-test comparisons or one-way ANOVA.

RESULTS: The majority of the respondents were female and were interested in pursuing professional schools (nursing and medicine). Survey results indicate high student interest in receiving mentoring, but few were active participants in a mentoring relationship. Respondents indicated either lack of knowledge or discomfort in identifying a mentor. While faculty mentors versus peer mentors were preferred, respondents indicated that mentoring by either faculty or peers would be of value. Survey results indicate that desired benefits of mentoring included guidance in future education and career decisions, networking and career advice.

CONCLUSION: The major conclusions are that despite high student interest in being mentored, their participation in mentoring is very low. These findings are supportive of the development of structured mentoring programs to facilitate and enhance mentoring of undergraduate STEM students and aid in their academic career progression.

KEYWORDS: undergraduate, biomedical, stem, mentoring, career progression

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Introduction

The increased demand for a diverse cadre of individuals with expertise in the STEM (science, technologies, engineering and mathematics) fields requires the use of intentional and strategic approaches to be used for enhancing recruitment, retention and career success. A commonly used intervention is academic mentoring which is associated with both positive career outcomes as well as positive self-image, emotional adjustment and psychological well-being.¹ Extensive literature indicates that mentorship is of substantial benefit to both the mentor and the mentee, a relationship that has been examined in nearly all disciplines.² Given this, many institutions of higher education reportedly encourage undergraduate mentorship. Despite good intentions, these efforts typically lack concrete plans or programs for promoting mentorship and their outcomes and success are not well characterized.³ Biomedical education which encompasses several disciplines including biology, kinesiology, microbiology, neuroscience, nursing and pre-nursing, pharmacology and psychology is of particular interest because of the profound shortage of biomedical professionals.⁴ These programs are all rigorous and demanding in their own ways, with a majority of STEM students feeling that they are academically challenged by their choice of major, as per a recent poll assessing the broad student opinions of academic programs and mentorship.⁵ The same survey demonstrated

better engagement among mentored students in their programs of study which the authors attribute to a more positive and confident attitude. Broadly speaking, the survey in question demonstrated the positive link between student satisfaction and mentorship; students that had positive mentoring experiences were more likely to report satisfaction and confidence in career placement as well. In best case scenarios, mentorship continued in a less formal capacity for years after graduation and contributed to career success.

A positive trend between mentoring and academic success is well established, with mentored students reporting better retention in their programs of study and enhanced satisfaction with their program choice.⁶ Further, students involved in a mentorship relationship were more likely to reach traditional benchmarks for academic success. These benchmarks include higher exam scores, better satisfaction with personal life and accomplishment, and greater extramural academic experience and achievement. As an extension of this, most mentored undergraduates report improved interest in their field of study setting them up for a lifetime of learning in their field, even after graduation and in the absence of additional education.² In the event that students do seek further education, mentorship positions them for higher rates of matriculation and success and aids their transition to graduate and professional education.⁷ The transition to graduate education can often be



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difficult and impede academic success or even deter retention in graduate programs.⁸ Mentored individuals who pursue additional education often harbor a perspective and attitude of adaptive learning, curiosity, and confidence that greatly contributes to their ability to secure a successful future.⁹

In addition to benefiting students, mentoring also provides substantial advantages to mentors. Similar to mentored students, early-career faculty members and peer-mentors involved in mentoring are more satisfied with their work and are, in general, more engaged with both their work and the advancement of student experiences outside of their expected roles as educators.⁶ Specifically, in the case of faculty mentorship, scholarship is significantly enhanced in institutions and departments that promote undergraduate mentoring. In addition, a mentoring-rich environment enhances student participation in undergraduate research and faculty shadowing. Thus, while students learn more and gain more skills, the faculty involved in their training and education gain invaluable help, novel ideas, and a fresh perspective that enhances the overall research environment and aids faculty in all of their endeavors.⁹

Although the benefits of mentorship are well understood and well explored, it is still unclear why the overall rates of mentorship remain so low. In a broad sense, the rates of mentorship in STEM undergraduate education are approximately 28% within all included majors.⁵ This means that only around one quarter of all STEM students are experiencing the benefits described above. Beyond the low overall rates of mentorship, the literature shows an alarming trend that underrepresented students are even less likely to seek out mentorship opportunities. Thus, groups that are already less able to access resources for success are less likely to seek out the mentorship opportunities that could fix this divide. Women in STEM are an underrepresented group that have been studied widely, with most undergraduate degree programs in STEM composed of less than 36% of freshmen who are female.¹⁰ There is no indication that this number is increasing, and it may even be the case that the number of female students in STEM is decreasing slightly with time. This is not surprising, as despite efforts to bridge the gap in representation, most college faculty members are still male. It has long been known that a key factor of mentor demographics that contributes to student success, particularly of females, is the gender identity of the mentor. It has been noted, even in the early literature, that the benefits of mentorship are unpredictable for females who are paired with male mentors.¹¹ A female student with access to one or more female mentors, either faculty or near-peer mentors, is likely to accrue the characteristic benefits from that mentor relationship. This is speculated to be a result of the confidence that comes from seeing a like-individual that has attained similar goals, and from the beneficial knowledge that can be imparted from one that has already overcome the systemic barriers that limit female matriculation and graduation from STEM programs.¹⁰ People of color follow a nearly identical paradigm of

disenfranchisement as females, although they have many unique concerns. Despite efforts to increase inclusive hiring practices, people of color are even further underrepresented in faculty. In addition, there is limited race, education and mindfulness training in the modern workforce.¹² As such, the disenfranchisement of students of color is made worse by the decreased likelihood of finding a mentor that is either mindful of the effect of race, or is of the same race as themselves.¹³ It is not speculation to state that inclusive mentorship practices in STEM, and by proxy in biomedical sciences, are beginning to remediate the deficits faced by underrepresented students especially females and people of color.¹¹ That said, the effects of other demographics such as age (as with non-traditional students), pre-professional plans, and primary major have not been assessed to the same degree in the literature.

Given the substantial benefits of mentoring and the fact that in biomedical education very few students seek out mentorship, the following goals of the project are apparent. First, what are undergraduate biomedical education student opinions and expectations on mentorship? Second, how can these student opinions and expectations be used to frame and define the ideal mentor relationship? While the scope of this study cannot encompass the entirety of underrepresented groups, there is particular emphasis on the gender identity and age of students studied and how their opinions vary.

Methodology

Setting

This study was conducted at a large, research, intensive public university in the southeastern United States to assess mentoring experiences of biomedical undergraduates as well as their expectations of mentors and the mentorship experience. The study was reviewed by the University's Institutional Review Board (#62067) to assure that the principles and recommendations of the Helsinki¹⁴ and Belmont¹⁵ were followed and was determined to be exempt from further review.

Participants

Students enrolled in the undergraduate biology, neuroscience and nursing programs were requested to take part in the survey, as they most broadly matriculate into graduate school and health care professions and thus are most indicative of the state of undergraduate biomedical education at the university. Total enrollment of undergraduate students at the institution in these majors were biology (1206), neuroscience (397) and nursing (811). The survey accrued 161 participants once adjusted for exclusion of unviable survey submissions as defined in "Procedures".

Survey Instrument

The on-line survey consisted of four sections and was intentionally designed to funnel students through a process of

identifying and reflecting on past mentor relationships. Prior to undertaking the survey, participants were provided with an explanation of the study and a consent form that was embedded within the survey. Participants were informed that survey results would likely be published and that participation was strictly voluntary. Queries in the first section of the survey pertained to demographics of the respondents and were limited to gender identity, age, year in college, academic major, major change history, pre-professional interests, and first generation student status. In the second section of the survey, general questions about previous experiences with mentorship were posed and allowed for hypothetical or otherwise speculative responses on mentorship for those who lacked mentorship experience. Questions within the third section addressed the ideal qualities of a mentor such as personality, the benefit they could provide a mentee, and whether or not the mentor was near-peer or professional/faculty. In the fourth section, the questions were more retrospective and sought to gain student opinions on factors such as whether a student would seek mentorship in the future and the overall value that mentorship could provide to them.

Procedures

The survey was conducted using Qualtrics (Qualtrics, Provo UT). To disseminate the survey, the administrative staff of each program was contacted and asked to organize a mass email to all students included on each respective email server. The surveys were distributed for a total of two weeks with a reminder email sent one week after the initial request. Inclusion criteria required respondents to confirm that they qualified as an undergraduate enrolled at the institution. Further, a participant could decline to answer any number of questions for personal comfort or could decline participation entirely. Results were excluded if less than 50% of questions had been responded to or if the response had not been completed and submitted within two days of starting the survey.

Measures

The first item assessed experience with and preferences regarding past mentorship. Participants selected the following options “I have never been involved in any mentorship”, “I have had experience with near-peer mentorship”, “I have had experience with faculty mentorship”, “I have had both types of mentorship” and “prefer not to answer”. Participants were then asked to select the types of mentorship they would feel most comfortable “near-peer, a close colleague or friend”, “faculty, a professional in your field”, “either variety would be fine”, “I do not desire a mentorship relationship of any kind” and “prefer not to answer”. In the third item, the length of their most recent mentorship experience was assessed. Participants chose “ < 1 year”, “1-2 years”, “> 2 years”, “I have never had a mentor relationship” and “prefer not to answer”. Items 4-8 assessed participant’s agency/barriers with respect to seeking

out mentorship. The items were “I have sought mentorship within my area of interest from a faculty mentor”, “I am likely to seek out mentorship of some kind in the future”, “I am uncertain on how to find a mentor to work with”, “If finding a mentor were easier I would have done it already” and “If finding a mentor were easier many of my colleagues would have chosen to seek mentorship”. Items 9-14 assessed perceptions on the value of mentorship and were “A relationship with a mentor can be important for success in many academic programs”, “A mentor has already progressed on the path that I am starting, so seeking their guidance should be useful to me”, “Mentors cannot tell me anything that I do not already know or that I could not easily find online”, “Of those in my program that have sought mentorship, I believe their retention and interest in the program is generally better”, “My personal experience with mentorship has positively impacted my retention in my program of study or even led me to this program” and “I believe that mentorship has/could have a positive impact on my academic performance as an undergraduate student. Items 15-21 assessed preferences with respect to mentorship and were “A mentor can be a near-peer to myself so long as they are devoted to their role and can provide me some benefit”, “While a near-peer mentor may be in touch with my needs and goals, it is better to rely on a faculty mentor first”, “I think that near-peer mentorship is ideal for my current mentorship expectations”, “I think that a faculty mentorship is ideal for my current mentorship expectations”, “A mentor must have a personality that matches closely with my own”, “A mentor could provide a benefit to my development even if we do not mesh personally” and “It is important but not preferred that a potential mentor has a similar personality to my own”. In items 4-21, participants rated the degree to which they agreed or disagreed from 1 (strongly disagree) to 7 (strongly agree) or (prefer not to answer). Items 22 and 23 assessed perceptions of the benefits of mentorship. In item 22, participants were asked to rank benefits of mentorship by order of importance using a scale of 1-6; “Career advice and counseling”, “Personal advice” (coping with stress, home/school balance, etc), “Academic support” (proofing papers, studying tips and resources, etc), “General encouragement of academic choices and progress”, “Planning and supporting further education (professional examinations, applications, etc) and “Networking. Item 23 was an open response and invited participants to briefly explain their choice for the most important benefit of mentorship using one to two sentences. Items 24 and 25 assessed participants’ preferences with respect to their interactions with mentors and asked “With what frequency would you ideally meet with a mentor”. Participants selected either “Weekly”, “Monthly”, “Once or twice per semester”, “Only when needed” or “prefer not to answer. In respect to “What mode of communication would you prefer to have with a mentor”, participants could choose “In person meetings”, “Phone calls”, “Email only”, “Text”,

“Video Call”, “More than one of the above” or “Prefer not to answer”. Finally, future plans with respect with mentoring were assessed. Item 26 stated “I will seek out mentoring experiences and opportunities in the future if there were a structured mentor matching program”, item 27 stated “I will seek out mentoring experiences and opportunities in the future on my own” and item 28 stated “I am comfortable reaching out to a potential mentor that I may not yet know personally”. In items 26–28 participants rated the degree to which they agreed or disagreed from 1 (strongly disagree) to 7 (strongly agree) or (prefer not to answer).

Response data was simplified to a three-theme format following completion of the survey to allow for grouping of questions for statistical comparison among the given demographic groups. Theme 1 revolved around the process for students identifying and finding a mentor. Theme 2 covered student perceptions on the importance of mentorship. Theme 3 was intended to identify the ideal properties of a mentor from the student’s perspective. Understanding of student perceptions on mentorship was further enhanced from responses to the short answer question, “briefly explain your choice for the most important benefits of mentorship using one to two sentences”.

Statistical Analyses

All responses, except for those given in short answer format, were converted to numerical scales for statistical purposes. Likert scale scores for each of the closed –ended questions were graphed using GraphPad Prism 8.0 (GraphPad Software, San Diego, CA) and the mean ratings and standard deviations were calculated for each question. Where indicated, survey responses were also grouped on the basis of three themes “Finding a Mentor”, “Importance of Mentoring” and “Mentoring Attributes”. Since all three of the theme measures met the assumptions for normality, all data was analyzed using parametric methods. For two group comparisons (ie, gender, 18 + 19 vs. > 20 years of age, first generation) statistical differences were identified by utilizing an independent samples t-test. For multiple group analyses (ie, program of study, pre-professional concentration), the data was analyzed using a one-way ANOVA. For analyses of themes, each theme’s additive response scores among all responders to the following demographic groups were compared: gender, program of study, age, pre-professional interests, and first-generation student status. Pearson’s correlation coefficient was utilized to look for significant correlations between the theme scores. All analysis was completed using IBM SPSS Statistics version 27 (IBM Corp, Armonk, NY).

Results

Characteristics of Respondents

The age distribution for survey responders ranged from a minimum of 17 to a maximum of 45 years of age (Table 1).

Table 1. Demographics of survey respondents.

Age (n = 118)	
Range	17-45
Mean	20 ± 3.1
Year in College	
Freshman	26 (24%)
Sophomore	42 (28%)
Junior	40 (27%)
Senior	23 (15%)
Super-Senior	4 (3%)
Post-Bac	3 (2%)
Prefer not to answer	2 (1%)
Gender (n = 150)	
Male	23 (15%)
Female	126 (84%)
Trans/Gender non- conforming	1 (0.7%)
First Generation (n = 150)	
Yes	39 (26%)
No	111 (74%)
Program of Study	
Biology	62 (41%)
Neuroscience	45 (30%)
Nursing or pre-nursing	36 (24%)
Other in STEM	6 (4%)
Other outside of STEM	1 (0.7%)

The mean age was 20 and the standard deviation was 3.1 which indicates that the data set strongly favors younger responders.

This was expected as most students in undergraduate programs are traditional students. In fact, nearly 90% of responders were between the ages of 18 and 21. This is reminiscent of the demographic data for year in college where nearly 93% of participants being a freshman, sophomore, junior, or senior with very few being a super-senior or post-bac undergraduate.

The gender distribution of responders was strongly in favor of females. Eighty-four percent of the responders identified as female, while 23% identified as male, and 1% identified as transgender or gender non-conforming. The data strongly favors females in this case, although it is not possible to state significance of turnout by gender.

The survey response rate was 6.7%. The response with respect to academic programs of study was 41% biology majors, 30% neuroscience majors, 24% nursing or pre-nursing

majors, and 5% other areas of study. This roughly reflects the relative size of each college in terms of student population.

Persistence in major and Career Aspirations

As an indication of persistence in major area of study, students were asked whether they had changed majors (Figure 1A). Results are given as percentage of responders from each group that had indicated they had or had not changed their major previously. A high number of responders (83%) within the “other STEM majors”, but only 8% of biology majors indicated that they had changed their majors. With respect to career aspirations, students were asked to indicate their interests in pre-professional concentrations (PhD, Dental, Medical or Nursing) (Figure 1B). Responses ranged from ~60% demonstrating

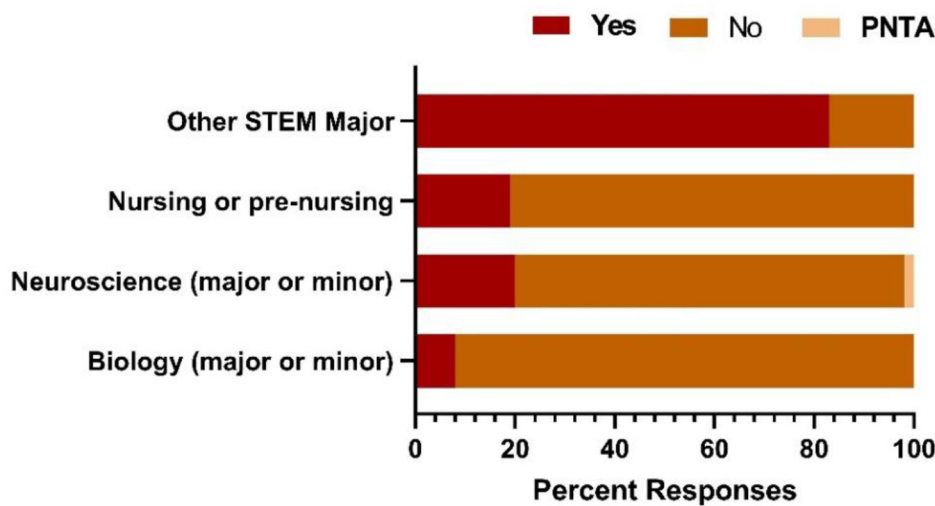
interest in pre-medical, but only ~3% interested in pre-dental concentrations. Both questions resolved to enhance the demographics of students for multiple group comparisons.

Mentorship Experience

Survey respondents were then asked to describe their past relationship with mentorship (Figure 2A). Of those surveyed, 52% had never had a mentorship relationship of any kind, 13% had been involved in faculty mentorship, 15% had a near-peer mentorship, and 19% had been involved with both kinds of mentorship. No significant differences between groups were observed.

As a follow-up, respondents were then queried with respect to the type of mentorship they would feel most comfortable (Figure 2B). Interestingly, 58% of respondents indicated that

A) Have you previously changed your program of study?



B) Are you interested in any of the following pre-professional concentrations?

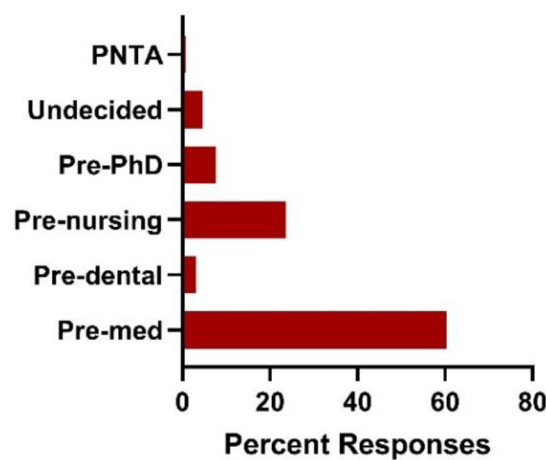
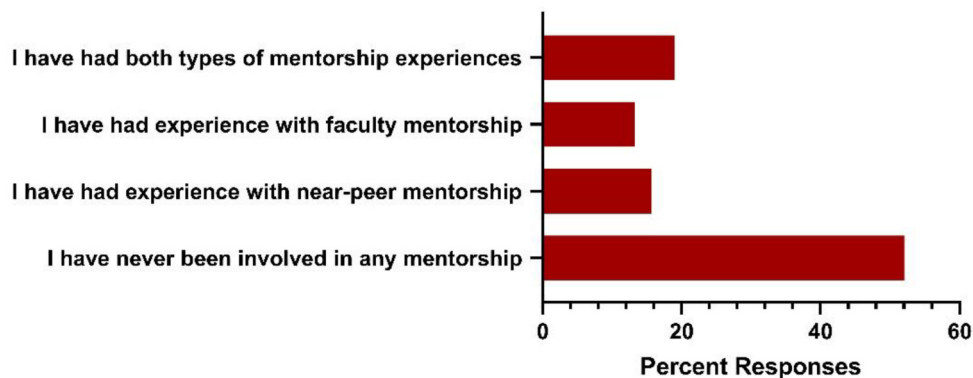
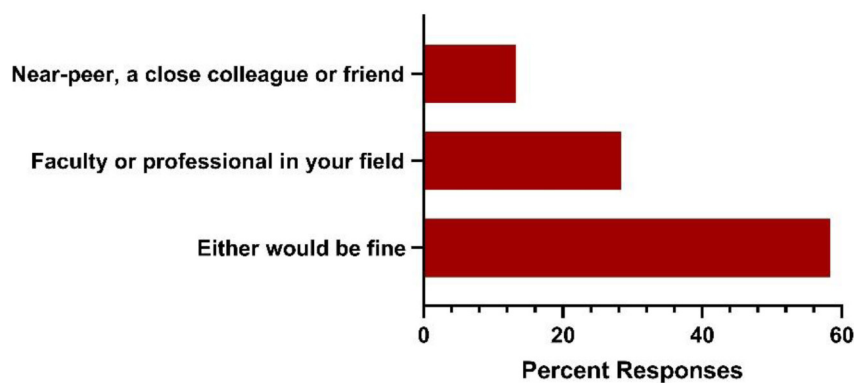


Figure 1. Persistence in major and interest in pre-professional concentrations. A) The relative percentage of respondents in each program that have or have not changed their academic major, given by percent of total respondents ($n = 150$). B) The percentage of respondents identifying themselves as interested in the indicated pre-professional concentrations.

A) Which of the Following Best Describes Your Past Relationship with Mentorship?



B) With Which of the Following Types of Mentorship Would You Feel Most Comfortable?



C) Finding a Mentor

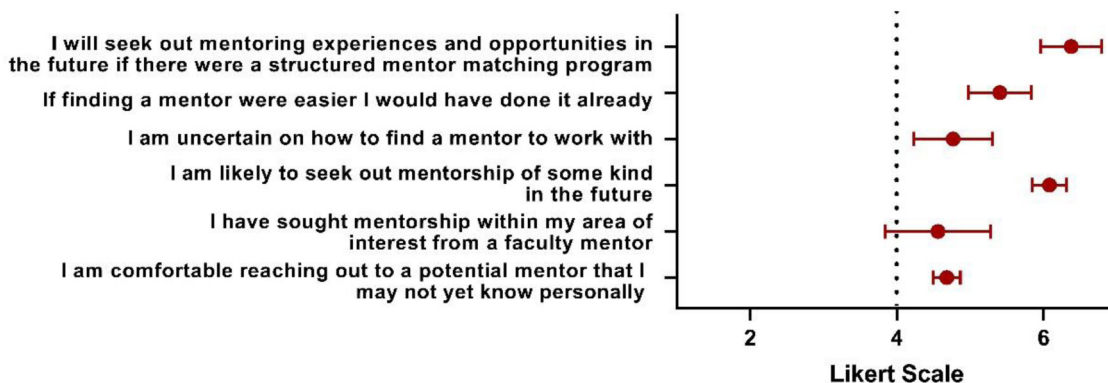


Figure 2. Experiences and interests in pursuing mentorships. **A)** Experience with mentorship. The percent of respondents who identified their experiences with previous types of mentorships. There were no respondents who chose neither type or declined to answer ($n = 121$). **B)** Interest in different types of mentorship. The percent of respondents who would be most comfortable with each type of mentorship. There are no respondents who chose neither type or declined to answer ($n = 120$). **C)** Finding a mentor. Mean Likert scores and standard deviations from survey questions addressing respondents uncertainty and future plans in finding a mentor ($n = 111-121$). Likert-scale categories from “strongly disagree” through “strongly agree” were adjusted to numerical scores of 1 through 7. The dashed line indicates a neutral (“neither agree nor disagree”) response. No significant differences between any demographic group was observed.

either faculty or near-peer mentorship was fine, with 13% preferring near-peer, and 28% preferring faculty mentors and zero responders declining any formal mentorship. Additional queries further addressed the issue of responder’s preferences for faculty versus near-peer mentorship (Not shown). When

asked whether they would prefer near-peer or faculty mentorship, the students predominantly agreed that faculty mentorship was right for them (reported by 81% of respondents) although the opinion of near-peer mentorship was also better than not being mentored at all (favored by 49% of respondents).

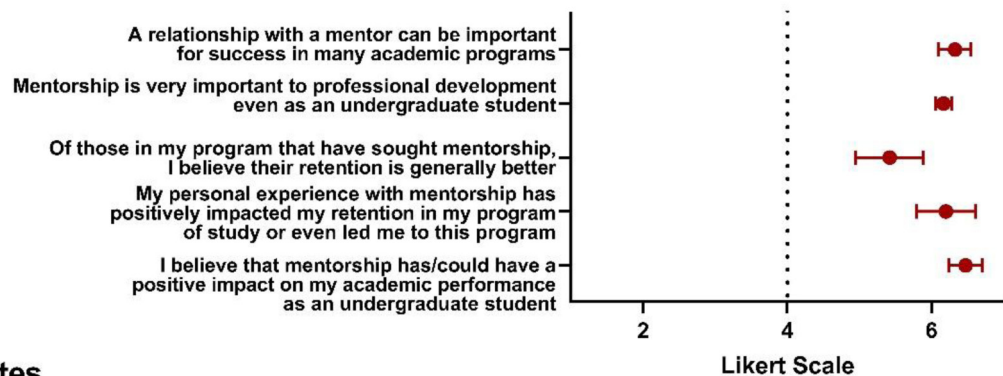
Students are generally on board with near-peer mentorship with 61% favorably responding (strongly agree, agree or somewhat agree) to the statement “I think that near-peer mentorship is ideal for my current mentorship expectations”.

Respondents were then asked a series of questions that addressed their interests in finding a mentor (Theme 1). Here, a 7-point Likert scale that ranged from “strongly disagree” to “strongly agree” were equated to numerical scores of 1 through 7 (Figure 2C). Respondents expressed very little comfort in reaching out to a potential mentor that they may not yet know personally (mean score, 4.68 ± 0.19). Respondents also expressed relatively low agreement with the statements “I have sought mentorship within my area of interest from a faculty mentor” (mean score, 4.56 ± 0.72) and “I am uncertain on how to find a mentor to work with” (mean score, 4.77 ± 0.53). Respondents indicated higher agreements with the statements “If finding a mentor were easier I would have done it already” (mean score 5.41 ± 0.43); “I am likely to seek out mentorship of some kind in the future (mean score, 6.08 ± 0.23) and “I will seek out mentoring experiences and opportunities in the future if there were a structured mentor matching program (mean score $6.38 \pm .41$).

Analyses of the Theme 1 sum score using ANOVA revealed emerging trends regarding differences in perception on finding a mentor between pre-professional concentrations ($p = 0.067$). Response scores from pre-dental students trended toward scoring the importance of finding a mentor below those of the other pre-professional groups, while Pre-PhD students trended towards higher theme scores.

We then sought to better understand respondents overall perceptions of the importance of mentorship (Theme 2) as well as mentor attributes (Theme 3) such as personalities (Figure 3). Respondents agreed that mentorship is very important to their professional development (mean score 6.17 ± 0.11), has or could have a positive impact on their academic performance (mean score 6.48 ± 0.24) and that a mentor relationship can be important for success in many academic programs (mean score 6.30 ± 0.23) (Figure 3A). Similarly, responders agreed that their personal experience with mentorship had positively impacted their retention in their program or led them to their program (mean score 6.20 ± 0.41). However, 29% of responders admitted that they had never been mentored (not shown). The general consensus on mentorship is positive

A) Importance of Mentorship



B) Mentor Attributes

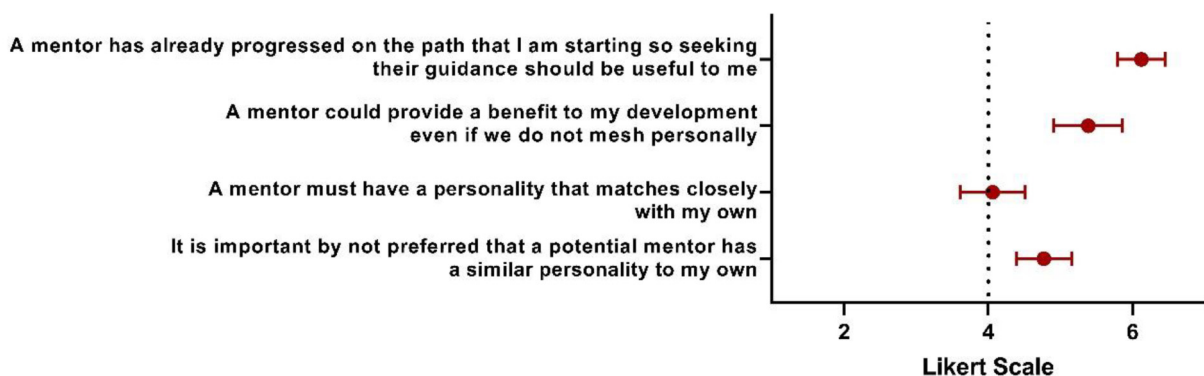


Figure 3. Importance of mentorship (A) and mentor attributes (B). A) Mean Likert scores and standard deviations from survey questions addressing the importance of mentorship Likert-scale categories from “strongly disagree” through “strongly agree” were adjusted to numerical scores of 1 through 7. The dashed line indicates a neutral (“neither agree nor disagree”) response ($n = 111-120$). B) Mean Likert scores and standard deviations from survey questions addressing mentor attributes ($n = 114-120$). No statistical difference between demographic groups with respect to Likert scale scores shown in panels A) or B) were observed.

with generally strong perceptions that retention is better among those who are mentored (mean score 5.42 ± 0.47).

While no significant differences in the combined Likert scores of Theme 2 were detected using ANOVA analyses, an emerging trend was observed ($p=0.074$). Here, respondents within the major programs present different perceptions on the importance of mentorship; Biology and Undecided STEM students trended toward higher response scores than Neuroscience and Nursing students suggesting that they hold a more positive view on the importance of mentorship.

Our next series of questions probed preferences for mentor attributes, in particular, personalities: these questions are the core of Theme 3 (Figure 3B). Responders agreed with the statement that “a mentor had already progressed on the path that I am starting, so seeking their guidance should be useful to me” (mean score 6.10 ± 0.33). With respect to personality, respondents agreed that a mentor could provide a benefit even if they did not mesh personally (mean score 5.39 ± 0.48). Interestingly respondent agreement that a mentor must have a personality that matches their own (mean score 4.06 ± 0.45) and that it was important, but not preferred that mentors shared similar personalities (mean score 4.77 ± 0.39) was lower. Analyses of Theme 3 indicated that no statistical differences existed between any demographic group.

We also queried whether relationships existed between the three themes using Pearson’s correlation. Here, a significant, positive correlation of 0.251 ($p=0.009$) was observed between “Finding a Mentor” (Theme 1) and Importance of Mentors” (Theme 2). A significant, positive correlation of 0.232 ($p=0.016$) was also observed between “Importance of Mentors” (Theme 2) and “Mentor Attributes” (Theme 3).

A final series of questions pertained to respondents preferred interactions with their mentors. More than 85% of responders

would like to meet monthly or more frequently with a mentor given the chance. With respect to interactions with their mentors, more than 70% would prefer a mixed modality of meeting and communication (ie, in person, phone calls, text and video calls).

To assess the aspects of mentoring that were of most value to the students, the survey then framed six key benefits of mentorship and students were asked to rank them by personal importance (Table 2). Of the six benefits that could be gained from mentorship, students consistently ranked three higher than the rest. The highest ranked benefit was planning, which was ranked as #1 by more than 26% of responders. The second highest ranked benefit was networking, which was ranked as #2 by more than 21% of responders. Finally, career advice was ranked #3 by more than 19% of responders.

In an open-response query, students were asked to “briefly explain your choice for the most important benefits of mentorship”. A word-frequency analysis of these responses is shown in Figure 4 and indicates that “support” and “advice” were among the most frequently used words.

Discussion

The purpose of this study was to elucidate the opinions and expectations of undergraduate STEM students regarding mentorship. Our major findings are that students are interested in the benefits and process of being mentored but do not seem to be participating at a rate that reflects this interest. Our results also reveal a number of interesting trends that have informed the following interpretations and recommendations in regard to the present and future approaches to mentorship in undergraduate biomedical education.

Table 2. Perceived benefits of mentoring. The number and percentage of all respondents that answered the corresponding survey question is given for each given benefit of mentorship; students ranked the benefits by personal importance on a scale of one to six with no duplicate rankings. The rank placement of each benefit is listed in the right column. Benefits were awarded a rank based on the first highest percentage obtained and no duplicate ranks were given. No statistical difference between demographic groups was observed ($n=106$).

	1	2	3	4	5	6	RANK
Planning and support of secondary education	28 (26.42%)	23 (21.7%)	24 (22.64%)	6 (5.66%)	10 (9.43%)	5 (4.72%)	#1
Networking	13 (12.26%)	23 (21.7%)	14 (13.21%)	26 (24.53%)	12 (11.32%)	18 (16.98%)	#2
Career Advice and Counseling	22 (22.75%)	21 (19.81%)	21 (19.81%)	20 (18.87%)	11 (10.38%)	11 (10.38%)	#3
General encouragement of academic choices and programs	5 (4.72%)	10 (9.43%)	18 (16.98%)	27 (25.47%)	29 (27.36%)	17 (16.04%)	#4
Academic Support (Proofing papers, study tips and resources, etc)	25 (25.38%)	14 (13.21%)	18 (16.98%)	20 (18.87%)	22 (22.75%)	7 (6.6%)	#5
Personal Advice (Coping with stress, home/school balance, etc)	13 (12.26%)	15 (14.15%)	11 (10.38%)	7 (6.6%)	12 (11.32%)	48 (45.28%)	#6

Why do Students Lack Mentorship?

Of all students surveyed, a majority had never had mentorship of any kind, although the number of students who had reported being mentored (47%) was similar to that reported previously (Figure 2A).^{5,16} In the current survey, a trend emerged that students are generally fine with either type of mentorship but, when made to choose, defaulted to faculty over near-peer mentorship (Figure 2B). A vast majority of students agreed to the importance of mentorship, acknowledged that the benefits of seeking and participating in being mentored are worthwhile and can make a great deal of difference in academic satisfaction and success. Despite these favorable perspectives on mentoring (Figure 3A), a majority of the surveyed students had never sought mentorship. Our findings indicate that two factors may explain this discrepancy: Students do not know how to find a mentor and they are not necessarily comfortable reaching out to an older peer or professional that they do not yet personally know (Figure 2C).

Student's difficulties in finding a mentor may arise from the "chilly climate" of the STEM disciplines wherein the culture focuses on promotion of new knowledge and research and places a low emphasis on professor-student relations.¹⁷ It has also been noted that a change in academia with regards to mentorship has arisen with faculty spending less time working one-on-one with students thereby allowing mentoring to "fall through the cracks".¹⁸ Possible remedies include shifting the attitudes within STEM disciplines to one that encourages connection and supports a warm learning environment. Our survey results also indicate that students prefer a structured mentor-matching arrangement presumably as it eliminates the stress of identifying and contacting a potential mentor. This aligns with previous studies which have indicated a need for more mentor training and structure to provide clarity about mentoring goals and clearly described mentoring functions and outcomes.^{6,18} A similar need for structured mentorship has been expressed by STEM faculty which has resulted in the successful implementation of at least one program that identified common behaviors of effective mentors and outlined best practices of mentorship.¹⁹ Finally, the need for structured mentorship is further emphasized in a recent report by the National Academies of Sciences which recommends a change from ad hoc mentorship to one that is intentional, inclusive and effective involving strong institutional leadership and support.²⁰

Is Mentor-Mentee Personality Match Important?

Interestingly, the personality of the mentor did not appear to be of high importance to the students surveyed in the current study (Figure 3B). Only about half of responders believed that a mentor should have a personality similar to theirs and a vast majority of students believed that a mentor could provide all benefits to them even if they did not mesh on a personal level. This is interesting because many programs and studies have sought to

optimize mentor matching using approaches such as personality profile matching and speed-dating.^{21,22} These are based in part on the role that a commonly used descriptor of human personality, known as the big-five personality traits (emotional stability, extraversion, openness to experience, agreeableness and conscientiousness) plays in the mentoring relationship and mentoring receipt.²³ Additional personality traits that appear to align with mentoring success include a sharing of common values between the mentor and their mentee.²⁴ Additional studies indicate that gender and age-differences may play a role in mentor preferences with women indicating higher preference for relationship aspects of mentoring and men preferring "powerful" mentors with positions of status.²⁵ Interestingly, as the age of the mentee increases the importance of the personal relationship with the mentor diminishes.

Our observation that a positive correlation exists between responses to "Importance of Mentors" and "Mentor Attributes" may indicate that students who place a high value on mentorship may be more discerning in establishing positive mentoring relationships. It is also possible that while undergraduate students may not perceive personality alignment to be of great importance preliminarily, the relationship may become less comfortable and less effective in the long term if the student and mentor are not well matched. An additional possibility is that for most undergraduate students, simply being mentored is enough such that the depth of the expected personal relationship with their mentor is not something that students prioritize. This perspective may evolve as mentees gain more self-efficacy with respect to identifying their needs and roles in establishing successful mentoring relationships.

What Benefits of Mentorship do Students Require?

In our study, students seemed to agree that of the many benefits of mentorship planning for future education or careers, networking, career advice and support were among the most important (Table 2 and Figure 4). Interestingly, studies of the effect of academic mentoring have shown that the most significant benefits lie within improvement of academic performance, attitudes and retention.¹ A key aspect that contributes to persistence and retention in STEM is science identity with low science identity, particularly within Hispanic women, found in undergraduate students majoring in biology, chemistry and physics.²⁶ The undergraduate experience is a critical period in a scientist's development as this is when a sense of belonging and scientific identity emerges. While there were limited statistical trends observed in our current study, knowing the expectations that students have for mentorship, and understanding that each student will want something else, is important in framing structured mentorship experiences. This would include fostering successful mentoring relationships by providing training for the mentee on "how to be a good mentee" and support for the mentors to be able to provide career advice and

Author Contributions

B.W. conceptualized, reviewed literature, designed and implemented the survey and wrote this paper. H.S. guided the design of the survey and edited this paper. A.S. provided statistical expertise.

Ethical Approval

This study was submitted to the University's Institutional Review Board and was determined to be exempt from review.

Informed Consent

Not applicable, because this article does not contain any studies with human or animal subjects.

Trial Registration

Not applicable, because this article does not contain any clinical trials.

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