The Mentoring Experience: Finding Value in Guiding Undergraduate Researchers

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Abstract

We discuss results from surveys of faculty involved in mentoring undergraduate research assistants in a summer program at Michigan State University. The goals of this study were: (1) to examine how mentors set expectations and communicated with students early in the research experience; (2) to explore the ways that mentors and students interact during the research experience; and (3) to explore mentors' experiences and attitudes after working with undergraduate research assistants. Anonymous, pre- and post-experience surveys were deployed to 118 research mentors, with >40% response rates. Analyzing the responses offers lessons for graduate students, post-doctoral scholars, and other new mentors of undergraduate researchers. These surveys also highlight key factors in successful mentoring relationships, which are important in preparing undergraduates for success in graduate school and for careers in academia and research.

Introduction

Many researchers have explored the value to students of participating in undergraduate research experiences. Engaging in research allows undergraduates to apply classroom knowledge in new settings;[1] explore or confirm major choices and career pathway;[2,3] and prepare for graduate study.[4–6] Participating in undergraduate research can also help retain and engage students, particularly those in populations that are historically underrepresented in STEM (Science, Technology, Engineering, Math).[7–10] One important component of successful undergraduate research experiences is that students are able to develop a mentoring relationship with faculty, graduate students, and/or other researchers who can provide guidance during the research process.[1,11–15] Often, these mentoring relationships persist over time and become a source of feedback and support as students navigate academic, professional and personal pathways.

Unfortunately, many colleges and universities still face significant challenges in recognizing the value of mentoring undergraduate researchers in regards to tenure and promotion expectations.[16] The benefits of having students engaged in a research experience are well documented,[17–20] but the impact of undergraduate research on faculty is not as clear. Quality supervising, training, and mentoring of undergraduate researchers often require a significant time commitment that is not generally recognized in teaching loads.[21] While many academics view research and teaching as complementary, the faculty reward system at research intensive institutions is driven first by research and second by teaching.[16,22] Thus, faculty may perceive that time devoted to working with undergraduate researchers detracts from their own scholarship.

The study described here is a preliminary effort to understand the experiences, attitudes and behaviors of undergraduate research mentors at Michigan State University (MSU). By gathering information about mentors' preparation, interactions with students, and attitudes about working with undergraduates, we hoped to better understand the needs of graduate students and faculty members serving in mentoring roles.

Survey Instruments and Methodology

MSU has a large population of undergraduate researchers, and for several years has conducted an annual survey of students' experiences, expectations and outcomes in research. Informal feedback has been collected from faculty research mentors over the years, but the study described here is the first institutional-level effort to examine the preparation, motivation and experiences of the mentors who participate in summer undergraduate research experiences. Two separate surveys were developed: a "Pre-Experience" survey administered during the first week of June and a "Post-Experience" survey administered in early August. The timing of these surveys coincided with the common calendar of various 10-week summer research programs on campus, which begin in mid-May and conclude at the end of July. Thus, the pre-experience survey was deployed about 10 days into the summer programs, and the post-experience survey was completed after the research programs concluded.

Both surveys were completed online, in response to an email distributed through the survey software. In an effort to encourage faculty mentor participation (and avoid the appearance of "checking up" on the mentors), it was decided to conduct both surveys anonymously. The pre-experience survey explored the research mentors' preparation for working with undergraduate researchers. Mentors were asked about how they planned to communicate with their undergraduate researchers, and whether they had discussed general expectations (e.g., student's role in the research, working hours) and more specific concerns (e.g., responsible conduct of research, lab safety or procedures). For classification purposes, the pre-experience survey asked mentors about their prior experiences with undergraduate researchers and their own role at the university (faculty member, post-doctoral scholar, etc.). The survey did not ask for other identifying demographic information (gender, ethnicity, discipline, etc.), in order to preserve the mentors' anonymity. Appendix A details the pre-experience survey questions.

The focus of the second survey was to understand how mentors actually interacted with their undergraduate research assistants, including details like how many hours per week, on average, were spent interacting with students and how the mentors provided constructive feedback. The post-experience survey also asked mentors to reflect on their own preparation for mentoring undergraduates, and to assess their satisfaction with the summer research experience. The post-experience survey questions are provided in Appendix B.

A pool of 118 research mentors was invited to complete both the pre- and post-experience surveys; these mentors were identified by their participation in one or more of the summer research programs at MSU, or through prior interactions with the MSU Office of Undergraduate Research. 47 mentors (40%) completed the pre-experience survey, and 56 mentors (47%) completed the post-experience survey. In keeping with the anonymous nature of the survey and our goal of encouraging mentor participation, none of the questions in the surveys required an

answer – thus, the total responses to individual questions does not always equal the number of surveys submitted.

Since the surveys were anonymous, they were not designed to involve direct comparisons of pre- and post-survey responses for individuals. However, both the pre- and post-experience surveys asked respondents to indicate their prior experience in mentoring undergraduate research assistants (both in total years of mentoring, and in total number of students mentored). The respondents proved to be experienced mentors; in the pre-survey, mentors reported an average of 9 years of prior mentoring experience, averaging 14 previous undergraduate mentees. On the post-survey, mentors averaged 10 years of prior experience and 15 prior research mentees.

As described below, several questions in the pre- and post-experience surveys were analyzed in the context of mentor experience. Responses within each survey were grouped for mentors with 0-5 years of prior experience and compared with responses from the group of mentors with 6+ years of experience.

Respondents' Role in the University

In both the pre- and post-surveys, the first question asked for the respondent's role at the university (i.e., faculty, post-doc, graduate student,). This question was inspired by anecdotal evidence that while undergraduate researchers were generally paired with a faculty mentor, the day-to-day supervision of research assistants was sometimes delegated to other members of the research group. Since we were interested in examining the experiences of those individuals most involved in mentoring undergraduate researchers, the invitation emails specifically requested that the survey be completed by the individual most involved in mentoring the undergraduate(s).

We were surprised to find that, on both surveys, more than 70% of respondents indicated that they were faculty members and about 20% of respondents were post-docs or graduate students. The few respondents who selected "other" included a post-bachelor lab manager and other research staff. Table 1 summarizes the respondents' self-identified roles at the University.

Table 1: Respondents by University Role

What is your role at the university?	Pre-Survey (n=47)		Post-Survey (n=56)	
	#	% of n	#	% of n
Faculty	34	72%	41	73%
Post Doctoral Scholar / Research Associate	5	11%	4	7%
Graduate Student	5	11%	6	11%
Other	1	2%	2	4%

Setting Expectations: Mentors' Early Discussion Topics with Student Research Assistants

A key component of the pre-experience survey was a question about the topics that mentors had discussed with their undergraduate research assistants. Setting clear expectations is an important component of successful mentoring relationships, and a failure to communicate clearly about

schedules, goals and deadlines can lead to difficult relationships between mentors and students. Thus, the pre-experience survey asked mentors whether they had discussed practical concerns (e.g., work schedules, lab safety, research procedures) and whether they had explored broader issues like the responsible conduct of research and the societal impact of research in this area. Since the pre-experience survey was deployed about 10 days into the summer programs, these responses capture mentors' conversations with students in the first week or two of the undergraduate research experience.

The response options for this set of questions were Yes/No/Not Applicable; responses could also be left blank. Respondents selected "Yes" or "No" in nearly all cases; one notable exception was six "Not Applicable" responses regarding discussions of safety training and lab protocol. By examining the frequencies summarized in Table 2, we determined that there were no significant differences between the "Yes" responses of mentors with 0-5 years of experience (n=22) and for mentors with 6+ years of experience (n=23).

Table 2: Pre-Survey Discussion Topics, by Years of Prior Mentoring Experience

Have you discussed the following with your student(s)?	0-5 years Experience (n=22)		6+ years Experience (n=23)		All Mentors (n=45)	
	Yes	% of n	Yes	% of n	Yes	% of n
Students' expected work schedules	21	95%	20	87%	41	91%
How students can seek assistance/answers for research-related questions	21	95%	23	100%	44	98%
How students will receive your constructive feedback on their work/performance	14	64%	13	57%	27	60%
Students' involvement in your group/team meetings	18	82%	22	96%	40	89%
Students' anticipated final product(s) by the end of the summer research program	17	77%	20	87%	37	82%
Safety training, lab protocol	17	77%	20	87%	37	82%
Responsible conduct of research	15	68%	19	83%	34	76%
Students' previous knowledge of your research area/topic	19	86%	18	78%	37	82%
Literature or information students should review prior to their research experience	17	77%	22	96%	39	87%
The intellectual merits or significance of your research area/topic (i.e., what "gap" your research addresses)	20	91%	22	96%	42	93%
The broader impacts to society of your research area/topic	17	77%	18	78%	35	78%
The value of the students' specific role within your research project/group	19	86%	22	96%	41	91%
Students' future plans or opportunities (i.e., graduate study, academia, non-academic careers)	16	73%	19	83%	35	78%

While there were no obvious differences between the discussion topics selected by more- and less-experienced mentors, combining the responses from both groups highlights interesting groupings among the topics. For instance, nearly all mentors chose to discuss logistics, the value of the research, and the student's role:

- 98% of mentors discussed how students can seek help for research-related questions
- 93% of mentors discussed the intellectual merits or significance of the research area/topic
- 91% of mentors discussed students' expected work schedules
- 91% of mentors discussed the value of the student's role within the project/group

Discussions of how the student would be integrated with existing research and laboratory/group processes were the next most common topic of conversation between mentors and students:

- 89% of mentors discussed how students would be involved in group/team meetings
- 87% of mentors suggested literature or information for students to review in advance
- 84% of mentors talked with students about their previous knowledge of the research area
- 82% of mentors discussed safety training and laboratory protocols
- 82% of mentors talked about expectations for the outcomes of students' summer research

Fewer conversations focused on the broader aspects of research or students' longer term goals, which is not surprising given that the mentors were reporting on conversations held near the beginning of a 10-week research experience:

- 78% of mentors discussed the broader social impacts of their research with students
- 78% of mentors discussed students' future plans (graduate study, careers, etc.)
- 76% of mentors discussed responsible conduct of research within their discipline

Just 60% of mentors reported in the pre-experience survey that they had explicitly discussed how they would be providing constructive feedback on students' work during the summer. It is unclear from these data whether mentors did not feel the need to explain the feedback process in advance, or whether this explanation may have taken place after mentors completed the pre-experience surveys. We found this result from the pre-experience survey interesting given the fact that on the post-experience survey, 100% of the respondents reported providing verbal feedback on students' work, and 64% reported also providing written feedback. Since all of the responses were anonymous it is not possible to correlate these two responses between the pre- and post-experience surveys, but it is an interesting area for future exploration.

Developing the Mentoring Relationship: Methods of Interaction

In the post-experience survey, we asked mentors to describe the average duration of their weekly interactions with their undergraduate research assistants. Most of the mentors (58%) reported that they averaged 1-5 hours per week of interactions with their student. An additional 25% of the mentors reported that they interacted with their student for 6-10 hours per week, on average.

A separate question on the post-experience survey asked mentors about the methods of interaction they used with their undergraduate research assistants. Mentors were able to select

all options that applied to their experiences, and Table 3 summarizes the "Yes" responses for various types of interactions, grouped by mentors' previous experience levels. A Chi-square test for independence (with Yates Continuity Correction) and Fisher's Exact Test indicated no significant association between novice and experienced mentors and how they interacted with their undergraduate researchers. The manner in which they interacted with students included individual interactions (p = .505), group interactions (p = .724), phone or video interactions ($\chi2$ (1, n = 53) = .029, p = .866, phi = -.066), email (p = 1), and text messaging (p = .633). This lack of significant association contradicts conventional wisdom that "newer" faculty member may be more likely to prefer "modern" communication methods. In addition to the interaction methods summarized in Table 3, a couple of mentors mentioned other methods of communication, including Facebook, and IRC (Internet Relay Chat, a computer-based instant messaging system). While this sample set is too small for detailed analysis, the responses do hint at continued evolution in the ways that mentors and students interact.

Table 3: Post-Survey Interaction Methods, by Years of Prior Mentoring Experience

How did you interact with your undergraduate student researcher(s)? Check all that apply.	0-5 years Experience (n=22)		6+ years Experience (n=31)		All Mentors (n=53)	
	Yes	% of n	Yes	% of n	Yes	% of n
In-person, individual interactions	22	100%	29	94%	51	96%
In-person, group interactions	17	77%	26	84%	43	81%
Phone and/or videoconference	7	32%	8	26%	15	28%
Email	19	86%	26	84%	45	85%
Text Messages	1	5%	3	10%	4	8%

Finding Value in Mentoring: Reflections on the Summer Experience

The final question of the post-experience survey asked the mentors to reflect on their preparation for mentoring undergraduates, and their satisfaction with the overall mentoring experience during the summer program. Again, the responses were grouped according to respondents' prior mentoring experiences, and were examined using an independent –samples t-test. There was no significant difference in the scores for statements related to feeling prepared to mentor, possessing mentoring expertise, the rewarding nature of the experience, contributions of undergraduates, mentoring relationships, and interest in working with undergraduates in the future. However, there was a significant difference for "I would have benefitted from formal mentor training prior to this research experience" between mentors with 0-5 years of experience ($M = 1.77$, $SD = .685$) and mentors with 6+ years of experience ($M = 2.42$, $SD = .672$; $t (51) = -3.424$, $p = .001$ (two-tailed)). The magnitude of the difference in the means (mean difference = -.647, 95% CI: -1.026 to -.267) was large (eta squared = .187). Similarly, there was significant difference for "I would change how I mentor undergraduate researchers in the future" between the novice group ($M = 2$, $SD = .873$) and the more experienced group ($M = 2.53$, $SD = .730$; $t (50) = -2.395$, $p = .020$ (two-tailed)). The magnitude of the difference in means (mean difference = -.533, 95% CI: -.981 to -.086) for this statement was moderate (eta squared = .103). Table 4

Table 4: Post-Survey Mentor Experiences, by Years of Prior Mentoring Experience

Please consider the undergraduate researchers you worked with this summer, and respond to the following statements by indicating your level of agreement using the scale: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree	0-5 years Experience (n=22)		6+ years Experience (n=31)		All Mentors (n=53)	
	Agree / SA	% of n	Agree / SA	% of n	Agree / SA	% of n
I felt prepared to mentor undergraduate researchers prior to this research experience.	22	100%	31	100%	53	100%
I would have benefited from formal mentor training prior to this research experience.	8	36%	3	10%	11	21%
I would change how I mentor undergraduate researchers in the future.	8	36%	4	13%	12	23%
I have mentoring expertise that would benefit newer colleagues.	12	55%	15	48%	27	51%
Working with undergraduate researchers was a rewarding experience.	19	86%	29	94%	48	91%
Working with undergraduate researchers positively contributed to my research agenda/process.	22	100%	29	94%	51	96%
I developed a mentoring relationship with the student(s) that will last beyond the summer experience.	21	95%	30	97%	51	96%
I am interested in working with undergraduate researchers in the future.	22	100%	31	100%	53	100%

summarizes the "Agree" or "Strongly Agree" responses (on a five-point Likert scale) for this set of questions.

In examining the combined responses for all mentors, it is notable that 100% of respondents felt that they were prepared to mentor undergraduates during this summer program. This is not surprising, given the relatively high level of prior experience of the mentors responding to this survey. Interestingly, only 51% of the respondents agreed or strongly agreed that they had mentoring experience that would be of benefit to newer colleagues, although an additional 47% had a neutral response to this question. It is not clear from the data whether there is truly a disconnect between mentors' confidence in their ability to work with undergraduates and their ability to translate that expertise to assist novice mentors. It is also possible that mentors' relatively lukewarm response to the question about transferrable expertise is related to their low interest (20%) in participating in formal mentoring training programs – perhaps hinting at a reluctance among mentors to expend their own resources on "mentoring the mentors."

While prior research has raised concerns about the burden of undergraduate research mentoring on faculty time and research agendas,[16,21,22] the participants in this study did not appear to believe that working with undergraduate researchers interfered with or detracted from their own scholarship. Indeed, 94% of mentors agreed or strongly agreed that working with their undergraduate researcher was a rewarding experience, and 96% of mentors developed a mentoring relationship that would likely last beyond the summer research experience.

Furthermore, 96% of the mentors agreed or strongly agreed that their work with their undergraduate positively contributed to their research agenda/process, while 100% expressed interested in working with an undergraduate researcher in the future.

Discussion and Future Work: Discerning Lessons for New Research Mentors

The goal of this study was to establish a baseline of information about the experiences, goals and needs of research mentors at Michigan State University. The mentors who chose to respond to these surveys had, on average, 8-10 years of prior experience mentoring undergraduate researchers. Certainly, this study has some significant limitations because these anonymous surveys were not designed to allow a one-to-one comparison of individual mentor's responses. However, as a preliminary effort to explore mentors' attitudes, preparation, and practices this study both highlights valuable practices of successful mentors and highlights areas warranting further study.

Respondents were grouped according to their years of previous experience (0-5 years, and 6+ years). While this analysis revealed very few statistically significant differences or associations between responses from mentors with more or less prior experience, that finding is in itself interesting: suggesting that the length of prior experience alone does not predict a mentor's satisfaction with undergraduate research. The sample set was not large enough to allow for a comparison of brand new mentors (with 0 years of prior experience) with more experienced mentors – and studying mentors with no prior experience presents significant logistical challenges. For instance, it is difficult to gather a large sample set of mentors with no prior experience, as many new faculty have opportunities to practice mentoring while they were in graduate school. Indeed, surveys of undergraduate researchers at MSU indicated that graduate students serve as the primary mentor in many disciplines. While we requested that this survey be completed by the person most involved in day-to-day supervision and mentoring of undergraduate researchers, the high response rate from faculty suggests that we may not have adequately captured the experiences of graduate student mentors on our campus.

In the post-experience survey, the mentors' reflections on the overall experience in working with undergraduate researchers was overwhelmingly positive, with nearly all respondents reporting that the undergraduates had helped to further their research agenda and 100% of mentors interested in mentoring undergraduates in the future. These surveys were not designed to directly correlate mentor's pre-survey discussions with their post-survey satisfaction reports. However, the general trends in these pre- and post-survey results suggest that mentors find value in discussing expectations and student roles early in the research experience. These data also indicate that undergraduate researchers can make substantial, positive contributions to faculty research agendas, sufficient to encourage mentors to continue working with undergraduate students.

Based on the results of these initial mentor surveys, we are planning additional studies and focus groups to refine some of the "best practices" of successful research mentors at Michigan State University and determine what types of support, information or training would be helpful to these mentors. Although the survey participants were largely experienced mentors who were not seeking formal mentor training, the expertise of these mentors has value for other groups at the

University, including current graduate students and new post-doctoral scholars, who may be interested in participating in research mentor training.

During the current academic year, two different types of mentor training are being explored at MSU. First is a series of panel discussions for faculty sponsored by the MSU Office of Undergraduate Research. Panelists are recruited from among the most experienced and successful mentors on campus, in different disciplines, and offer their practical suggestions for successfully working with undergraduate research assistants. By focusing on "tips and techniques" for managing research students, this seminar series has been successful in gathering faculty mentors who might not otherwise be interested in "training" programs. The second activity is a series of professional development seminars for Engineering graduate students who are interested in academic careers. Through monthly lunchtime gatherings, these students have been introduced to key concepts (like the role of research in engineering education) and practical suggestions for working with undergraduates (like providing effective feedback). We are continuing to assess these activities for faculty and graduate students to determine how best to support undergraduate research mentors, with the goal of providing high-quality research experiences to undergraduates while also supporting the academic and professional goals of faculty and graduate student mentors.

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Appendix A: Research Mentor Pre-Experience Survey

1. What is your role at the university?
   - Faculty
   - Post-Doctoral Scholar / Research Associate
   - Graduate Student
   - Undergraduate Student
   - Other: please specify _____

2. **Prior** to this summer experience, how many undergraduate researchers have you mentored? Please enter a whole number, 0 or greater.

3. **Prior** to this summer experience, for how many **years** have you mentored undergraduate researchers? Please enter a whole number, 0 or greater.

4. How do you plan to interact with your undergraduate student researcher(s)? (check all that apply)
   - In-person, individual interactions
   - In-person, group interactions
   - Phone calls / videoconferencing
   - Email
   - Other: please specify _____

5. Have you discussed the following with your student(s)?
   (Exclusive response options: Yes, No, Not Applicable)
   - Students' expected work schedules
   - How students can seek assistance/answers for research-related questions
   - How students will receive your constructive feedback on their work/performance
   - Students' involvement in your group/team meetings
   - Students' anticipated final product(s) by the end of the summer research program
   - Safety training, lab protocol
   - Responsible conduct of research
   - Students' previous knowledge of your research area/topic
   - Literature or information students should review prior to their research experience
   - The intellectual merits or significance of your research area/topic (i.e., what "gap" your research addresses)
   - The broader impacts to society of your research area/topic
   - The value of the students' specific role within your research project/group
   - Students' future plans or opportunities (i.e., graduate study, academia, non-academic careers)

Appendix B: Research Mentor Post-Experience Survey

1. What is your role at the university?
   - Faculty
   - Post-Doctoral Scholar / Research Associate
   - Graduate Student
   - Undergraduate Student
   - Other: please specify _____

2. **Prior** to this summer experience, how many undergraduate researchers have you mentored? Please enter a whole number, 0 or greater.

3. **Prior** to this summer experience, for how many **years** have you mentored undergraduate researchers? Please enter a whole number, 0 or greater.

4. How did you interact with your undergraduate student researcher(s)? (check all that apply)
   - In-person, individual interactions
   - In-person, group interactions
   - Phone calls / videoconferencing
   - Email
   - Other: please specify _____

5. On average, how many hours per week did you interact with your undergraduate student researcher(s)?
   - 0
   - 1-5
   - 6-10
   - 11-20
   - 21-30
   - 31-40
   - 41+

6. How did you provide constructive feedback to your undergraduate student researcher(s)? Check all that apply.
   - Verbal feedback
   - Written feedback
   - Other: please specify _____

7. Please consider the undergraduate researchers you worked with this summer, and respond to the following statements by indicating your level of agreement using the scale: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree
   - I felt prepared to mentor undergraduate researchers prior to this research experience.
   - I would have benefited from formal mentor training prior to this research experience.
   - I would change how I mentor undergraduate researchers in the future.
   - I have mentoring expertise that would benefit newer colleagues.
   - Working with undergraduate researchers was a rewarding experience.
   - Working with undergraduate researchers positively contributed to my research agenda/process.
   - I developed a mentoring relationship with the student(s) that will last beyond the summer experience.
   - I am interested in working with undergraduate researchers in the future.