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Evaluating the Impacts of Undergraduate Research Programs at Mississippi State University for Developing Science Professionals

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Evaluating the Impacts of Undergraduate Research Programs at Mississippi State

University for Developing Science Professionals

By

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Candidate for the Degree of Undergraduate Honors

Since 2013, Mississippi State University has been offering research experiences for undergraduates through formal programs which pair high-performing students in collaborative research with faculty mentors. The purpose of these programs is to provide students with the opportunity to enhance scholarly activity, participate in the discovery of new knowledge, and become a part of the scientific community. We tested the hypotheses that undergraduate research improves student participants' educational experience (including personal and professional development), enhances retention of talented students in science careers, and leads to discovery of new information that contributes to the larger body of knowledge, while also looking at faculty motivations, benefits, and challenges they face in mentoring an undergraduate. Preliminary data from surveys of past program participants indicate improved discipline-specific knowledge, greater understanding of the scientific process, and enhanced interest in graduate education in STEM fields. Results also indicate undergraduate students are significant contributors to the larger body of scientific knowledge, including participating in

meaningful research activities, serving as co-authors on peer-reviewed papers, and presenting research at local, state, national, and international levels. These outcomes suggest guided undergraduate research programs are an effective mechanism for increasing scientific literacy among college students and recruiting new scientists to STEM career fields.

DEDICATION

To my family, for giving me the necessary push to chase my dreams and become successful in my career.

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CHAPTER I

INTRODUCTION

Undergraduate research is defined as "an inquiry or investigation conducted by an undergraduate that makes an original intellectual or creative contribution to the discipline" or, "the apprenticeship model of learning" (Hunter et al., 2007). The "best practice" for undergraduate research occurs when the student utilizes the expertise and mentorship of the research advisor but is encouraged to take on primary responsibility of the project (Hunter et al., 2007). Since 2013, the Forest and Wildlife Research Center at the College of Forest Resources and the Mississippi Agricultural and Forestry Experiment Station at the College of Agriculture and Life Sciences, both at Mississippi State University (MSU), have been conducting the Undergraduate Research Scholars Program (URSP). Along with MSU's Office of Research and Economic Development (ORED) undergraduate research program, these competitive grant programs engage high-performing, research-oriented undergraduates in collaborative research with faculty mentors for the purpose of providing students with the opportunity to "enhance scholarly activity" and "discover new knowledge". Both students and faculty apply for funding through these programs, and the faculty that are chosen by the program directors are then able to hand-select the student they believe fits best with their research interests. Students are paid an hourly stipend for their work and have funding to cover participation in conferences in which they can present research results. These programs normally last one year.

Although deemed successful and worth replicating in other MSU units, the impacts of these programs have not been evaluated at MSU. Using funding provided by the College of Forest Resources 2018 URSP, I tested the hypotheses that undergraduate research improves student participants' educational experience (including personal, cognitive, and professional development), enhances retention of talented students in science careers, and leads to discovery of new information that contributes to the larger body of knowledge. I also assessed the impact of these programs on participating faculty members, with emphasis on the personal and professional benefits or disadvantages to their involvement in such opportunities.

I conducted surveys of student and faculty participants of the URSP and ORED programs to assess short- and mid-term outcomes related to participants' personal and professional development. The survey instrument was modeled after Hunter et al. (2007) who survey students from four liberal arts colleges and universities to answer the following questions:

1) What are the benefits of undergraduate research as identified by students—both shortly following the experience and in the longer term (e.g., career outcomes);

2) What gains do faculty advisors observe in their student researchers and how do their views of these gains agrees or disagrees with those reported by students;

3) What are the benefits and costs to faculty for engagement in undergraduate research;

The purpose of this research was to address these questions at a land grant university with a strong research mission and performance record.

CHAPTER II

STUDENTS AND UNDERGRADUATE RESEARCH

2.1 Literature Review

Undergraduate research is becoming increasingly prevalent among US universities and colleges. Undergraduate research is defined as "an inquiry or investigation conducted by an undergraduate that makes an original intellectual or creative contribution to the discipline" or, "the apprenticeship model of learning" (Hunter et al., 2007). The "best practice" for undergraduate research occurs when the student utilizes the expertise and mentorship of the research advisor but is encouraged to take on primary responsibility of the project (Hunter et al., 2007). In 1998, the Boyer Commission released a document providing ten recommendations for research universities for reconstruction of their undergraduate education, primarily by placing more emphasis on undergraduate research (*Boyer Commission on Educating Undergraduates in the Research University*, 1998). The commission argued for an educational system in which both students and faculty play the roles of learners and researchers.

Undergraduate research leads to gains in participating students' understanding of research processes, confidence in communication, and other professional skills. For example, Lopatto et al. (2004) reported a majority of undergraduate student researchers felt they had gained skills in science readiness, particularly in understanding of the

research process, readiness for more demanding research, and understanding how scientists work on real problems. Another study determined 88% of survey respondents increased in their understanding of how to conduct a research project, and 83% had a higher level of confidence in research skills (Russel et al., 2003). Seymour et al. (2004) indicated 91% of students gained professional science-related skills from their undergraduate research experience, and Bauer et al. (2016) found the highest ranked gains were in becoming "intellectually curious, independent, and logical thinkers and problem solvers".

Undergraduate researchers also experience gains in personal and more general professional development. Improved self-confidence, tolerance in others, and scientific awareness may be achieved through undergraduate research (Sabatini et al., 1997; Mabrouk et al., 2000; Russel et al., 2003; Lopatto et al., 2004), as well as gains in effective public speaking, information acquisition and critical analysis, leadership, and thinking independently (Sabatini et al., 1997; Gregerman, 1999; Kardash, 2000; Marbrouk et al., 2000; Bauer et al. 2016). Kardash (2000) concluded that a majority of students experience gains in oral communication, while another study determined that the highest-ranked skill students gained was a healthy professional self-confidence (Mabrouk et al., 2000). Lopatto et al. (2007) indicated students benefited by being learning to work independently and becoming part of a learning community.

Students who participate in undergraduate research in science disciplines tend to continue in a science-based field. A 2002 survey of undergraduate student researchers determined that 75.6% of respondents pursued further science education after receiving a baccalaureate degree (Hathaway et al.) Lopatto et al. (2004) concluded that

undergraduate research experience either solidified or changed undergraduate students' prior plans in support of postgraduate science education in 30% of survey respondents; the majority (57%) already had a plan to pursue postgraduate education that did not change. A separate study indicated only 4.2% of undergraduate researchers changed their post-graduation plans away from higher science education (Lopatto et al. 2007). Russel et al. (2007) reported 29% of surveyed undergraduate student researchers had a new plan to pursue a Ph.D. Bauer et al. (2016) reported significantly higher probability of graduate education among those students with research experience (67%) than those with no research experience (57%). Eagan, Jr. et al. (2013) support this result, stating that these programs provide undergraduate researchers with the opportunity to widen their academic knowledge while also developing who they are as scientists, leading to a greater likelihood of further degrees and/or career in Science, Technology, Engineering, and Math (STEM).

Students who conduct undergraduate research share their outcomes and contribute new information to the larger body of science knowledge. For example, one study determined 45.5% of faculty members had student researchers present a poster at a regional, national, or international conference, 41.2% had students present at a university-level research conference, 33.3% had a student co-author a submitted manuscript, and 33.3% also had a student orally present at a regional, national, or international conference (Buddie et al., 2011). Hunter et al. (2007) found 28% of all undergraduate researchers presented at off-campus conferences in addition to a mandatory on-campus science conference.

Other research has shown that faculty involvement in undergraduate research has a large effect on the success and overall research experience of students. Hunter et al. (2007) determined that 16% of students' observations about their research programs included descriptions of the importance of establishing relationships with faculty members; one student said that "…it's really wonderful to be in such a give-and-take with a professor….[we're] working through something that is new for both of us." In a separate study, undergraduate researchers responded that the support, guidance, and collegiality they received from their faculty mentor is one of the

leading factors of their increase in personal and professional confidence (Seymour et al., 2004).

Russel et al. (2007) did not find a positive correlation between mentorship and a positive undergraduate research experience; nevertheless, when given a chance to elaborate on what could be improved about their undergraduate research, a majority of undergraduate student researchers responded that more effective faculty guidance was needed, highlighting the relationship between faculty mentoring and student research success. Howitt et al. (2009) determined a major factor contributing to a student's research experience was the supervisor. Students who said they had a positive experience made comments such as "an organized, enthusiastic supervisor" or "my supervisor was amazing…the research and report I produced were...the best pieces of work I've produced…and it was largely because of him." Those students who described their worst experiences also commented on the quality of the supervisor, such as "[the] supervisor was never around" and "poor guidance and little feedback from [the] instructor" (Howitt et al., 2009). This research, suggests that mentors who were enthusiastic and supportive

of undergraduates' research played a large role in producing positive outcomes for undergraduate students.

Federal organizations such as the National Science Foundation and the US Department of Agriculture sponsor research experiences for undergraduates, as do individual institutions of higher learning. Since 2013, Mississippi State University (MSU) has been conducting the Undergraduate Research Scholarship Program (URSP) through its College of Forest Resources and College of Agriculture and Life Sciences, providing undergraduates with the research opportunities called for by the Boyer Commission. Along with MSU's Office of Research and Economic Development (ORED) undergraduate research program, these competitive grant programs engage high-performing, research-oriented undergraduates in collaborative research with faculty mentors for the purpose of providing students with the opportunity to "enhance scholarly activity" and "discover new knowledge." Both students and faculty apply for funding through these programs, and the faculty that are chosen by the programs directors are then able to hand-select the student they believe fits best with their research interests. Students are paid an hourly stipend for their work and have funding to cover participation in conferences in which they can present research results. These programs normally last one year.

Previous research documents the importance of undergraduate research, but southeastern US schools are largely unrepresented in these studies. Mississippi State University is a southeastern, land grant institution that is classified as a Carnegie Foundation Very High Research Activity doctoral university and is ranked by the National Science Foundation as a "Top 100" research university. The purpose of this

study is to test whether benefits reported in the literature will be observed at a very high research, land-grant university that serves a diverse student body from states (including Mississippi) which are not known for high science achievement at the K-12 level (NAEP 2015). This project will determine if undergraduate research at MSU affects student participants' education experience, retention of talented students in science careers, and addition of new information into the larger body of science knowledge.

I hypothesized that undergraduate research at MSU:

1. improves student participants' educational experience (including personal, cognitive, and professional development),

2. enhances retention of talented students in science careers, and

3. leads to discovery of new information that contributes to the larger body of knowledge.

This study will assess undergraduate participants' educational development as a result of undergraduate research, ascertain retention of students in a science based career field, and determine the contribution of undergraduate projects to the larger body of science knowledge.

2.2 Methods

2.2.1 Participants

Names of undergraduate researchers were obtained from directors of the URSP and ORED programs. Contact information was gathered from program records. Participants were notified in advance of the upcoming survey via email as a means to test

email validity. If student email addresses had been deactivated, these students were contacted via a secondary email, phone, and/or social media platform.

2.2.2 Survey Instrument

My survey instrument was based on surveys reported in published literature (Hathway et al. 2002; Lopatto et al. 2004; Hunter et al. 2007; Russel et al. 2007; Howwit et al. 2009), and it included some additional questions I developed that were specific to the MSU programs.

The survey included items related to participants' demographic characteristics (age group, gender, and race), research projects and outputs, and personal & professional growth (see Appendix A for the survey instrument). For example, questions included the number of research projects the participant conducted as an undergraduate, if he/she still maintains contact with his/her faculty mentor, the number of publications and conference presentations that resulted from the research, and the student's plan to pursue advanced education. Participants were also asked to rank professional science readiness skills on a Likert scale of 1 to 5 (1-none, 2-minimal, 3-average, 4-above average, and 5-excellent) before and after undergraduate research.

The survey was approved by MSU's Institutional Review Board (project approval number, IRB-18-487). Surveys were emailed out to participants via a link provided by Qualtrics® (Qualtrics, Provo, UT), and reminders were sent out at 2-weeks post initial email and 4-weeks post initial email (Dillman, 1986).

2.3 Results

Between 2013 and 2018, 298participants participated in one of the three MSU-sponsored programs. Of these, 236 participants were contacted and sent the survey, and 74 responded to the survey. However, only 45 of the respondents filled the survey out completely for a 31% response rate and a 19% completion rate.

Survey participant ages ranged from 17 to 28 years old. A total number of 72 projects were conducted in 14 departments (Table 2.1). On average, and they conducted research in 14 different departments (Table 2.1). On average, students had participated in 1.8 research projects, ranging from 1 to 5 projects.

Participants rated gaining experience for future education/jobs (87% of respondents) and expanding their understanding of research (74% of respondents) as important or very important factors influencing their decision to conducts undergraduate research. The least important factor was being required to partake in undergraduate research by scholarship or other academic requirement (76% of participants rated not important or minimally important). Working with a particular faculty member and making additional money were rated similarly between the participants who thought these factors were important and those that did not.

Table 2.1 Research departments and number of projects in each department.

MSU Department	Number
Agriculture Economics	5
Animal and Dairy Sciences	6
Biochemistry	11
Biological Sciences	1
Chemistry	2
Communication	4
Computer Science and Engineering	1
Food Science, Nutrition, and Health Promotion	2
Forestry	6
Human Sciences	3
Industrial and Systems Engineering	2
Plant and Soil Sciences	1
Sociology	3
Sustainable Bioproducts	1
Wildlife, Fisheries and Aquaculture	17
Other	7

Undergraduate research at MSU produced scientific outcomes. A total of 48 students presented outcomes of 78 projects at a professional meeting and/or conference. Forty-five percent (n=35) of projects were presented at a university conference, 13% (n=10) presented at a state conference, 21% (n=16) at a regional conference, 11.5% (n=9) at a national conference, and 4% (n=3) at an international conference. The majority (89%, n=61) of these presentations were posters and 19% were given orally. Fifty-three students presented their work at a MSU sponsored research symposia [8% (n=4) as oral presentations; 92% (n=49) as poster presentations]. Nine students have published research results as co-authors, 78% (n=7) of these in a peer-reviewed journal, 11% (n=1) in a conference proceedings, and one publication was unspecified by the survey participant. For those projects that have not yielded publication, 37.5% of UR participants reported no plans to publish their results, 26.5% had plans but had not started

writing the manuscript, 31% were in the process of publishing, 3% had a manuscript submitted, and 1.5% had a manuscript in review.

Undergraduate research projects conducted at MSU impacted student participants' intentions toward graduate school (Table 2.2). Ninety one percent of participants said that undergraduate research confirmed their decision to pursue graduate school or changed their decision towards pursuing graduate school. Nine percent of participants had no plans to pursue further education, and out of this nine, only two percent of participants were turned away from the idea of graduate school after their undergraduate research experience.

Table 2.2 Impact of Undergraduate research on graduate school aspirations

Survey item	n
UR* confirmed decision	33
UR changed decision towards	8
UR changed decision away	1
Still no plans for graduate school	3

* UR= undergraduate research

Undergraduate research experience improved student participants' readiness for science. The greatest change in professional science readiness was in integration in theory and practice (Table 2.3). Other important science skill areas which showed improvement were readiness for more demanding research, skills and knowledge of lab

and/or research techniques, meaningful relationships with professional mentors, and

understanding of ethical conduct. The least improved skills as a result of undergraduate

research were in listening and teamwork.

Table 2.3 Measurement of professional science readiness pre- and post- undergraduate
research
        UR)

Skills	Pre-UR Mean Score	Post-UR Mean Score	Change
Integration of theory and practice	2.4	4.0	2.6
Understanding of research processes	2.5	4.2	1.8
Skills and knowledge of lab and/or research techniques	2.4	4.0	1.8
Readiness for more demanding research	2.4	4.2	1.8
Meaningful relationships with professional mentors	2.7	4.4	1.7
Understanding of ethical research conduct	2.6	4.2	1.6
Credibility with faculty members and colleagues	2.8	4.4	1.5
Membership within the learning and/or scientific community	2.2	3.7	1.5
Data analysis	2.3	3.7	1.4
Interpretation of research results	2.4	3.8	1.4
Understanding of primary literature	2.6	4.0	1.4
Understanding of how knowledge is constructed	2.8	4.2	1.3
Scientific writing skills	2.5	3.8	1.3
Oral presentation skills	2.9	4.0	1.0
Self-confidence	2.9	3.9	1.0
Toleration of obstacles	3.2	4.1	0.9
Independent learning skills	3.3	4.2	0.9
Critical thinking skills	3.4	4.2	0.8
Skills in following directions/instructions	3.6	4.3	0.7
Leadership skills	3.3	3.9	0.7
Listening skills	3.5	4.2	0.6
Teamwork skills	3.5	4.2	0.6

2.4 Discussion

This work has been the first look at the effects of undergraduate research on MSU students. We determined that undergraduate student researchers are mostly motivated to participate in these programs by the opportunity to gain experience for future education & jobs and expand their understanding of research. Few were participating because they were required to do so by academic programs or scholarships.

A goal of the MSU URSP & ORED undergraduate research projects is to provide students with the opportunity to "discover new knowledge." This project showed that undergraduate student researchers do discover new information that contributes to the larger body of knowledge. Our results mirrored those found by Buddie et al. (2011) and Hunter et al. (2007), finding that a great number of undergraduate student researchers produced outputs of their project, including presentations at conferences globally and co-authored publications. Furthermore, multiple professors are currently working with students and plan to work with students in the future, so this contribution to science will continue to increase as new projects develop.

We also found that undergraduate research at MSU enhances the retention of talented students in science careers, specifically in higher education. Our results are supported by other publications that determined the same phenomenon (Hathaway et al., 2002; Lopatto et al., 2004; Lopatto et al., 2007; Russel et al., 2007; Eagan, Jr. et al., 2013; and Bauer et al., 2016). This relationship indicates that undergraduate research, when studied at a high ranking scientific university in the southeast or liberal arts schools spanning the country, have similar effects on undergraduate student researchers' decision to pursue further education in science.

Undergraduate research was also proven to improve student participants' educational experience, including personal, cognitive, and professional development. All science readiness skills were rated as above average after participating in undergraduate research and had at least a 0.7 improvement from pre-program abilities. Our results mirrored those found in other undergraduate research studies. Personally, students developed leadership skills, teamwork skills, and self-confidence (Sabatini et al., 1997; Mabrouk et al., 2000; Russel et al., 2003; Lopatto et al., 2004). Cognitively, students developed their critical thinking skills, understanding of primary literature, and understanding of the research process (Sabatini et al., 1997; Gregerman, 1999; Kardash, 2000; Marbrouk et al., 2000; Russel et al., 2003; Lopatto et al., 2004; Bauer et al., 2016). Professionally, students developed meaningful relationships with their mentors, credibility with faculty members and other colleagues, oral presentations skills, and scientific writing skills (Kardash, 2000; Seymour et al., 2004; Bauer et al., 2016).

"My projects were enlightening and educating….I feel honored and

blessed to have worked on this project because it taught me how to

work with a team and

how to conduct research using the scientific method."

Students also reported that faculty members have a significant impact on undergraduate students' research experiences. Some participants explained how undergraduate research provided them with the opportunity to relate classroom training to real world application:

"…faculty mentorship in a structured system…allows students who

typically have little more than classroom experience to use that training

in real world application to make the connection between simple data

collection and data application."

Another survey respondent provided this comment regarding their faculty

research mentor:

"… My [undergraduate research] professor was and continues to be one

of the best mentors I have ever had. She has opened so many doors for

me and sought out every chance possible to help me learn."

Other examples of positive mentor-student relationships include the relationship

between mentor, undergraduate research, and the current employment of the student in

other science fields:

"I really was lucky to have a very supportive supervisor who has kept

in contact with me since my graduation and supported various

applications/endeavors. Undergraduate research was key for my

experience at MSU and is a core factor both for my employment as an

organic chemist in an industry lab and for my recent admittance to PhD

programs in Biochemistry."

However, some students experienced a negative relationship with their faculty

mentor and in turn, did not enjoy their undergraduate research experience.

"My original project…fell through…so my professor had to scramble to

come up with something new for me…I felt like a burden for a majority

of the experience…If the grad student had not been so exceptional and

kind, it would have been a real terrible experience…I excelled despite

my professor's unwillingness to help me."

The importance and impact of the relationship between mentor and

undergraduate student on undergraduate student research found in this project

resembles the relationships identified in other publications (Seymour et al.,

2004; Hunter et al., 2007; and Howitt et al., 2009).

2.5 Conclusion

This project demonstrated that the three formal undergraduate research programs

at MSU improve student participants' educational experience (including personal,

cognitive, and professional development), enhance retention of talented students in

science careers, and lead to discovery of new information that contributes to the larger

body of knowledge. Through student feedback, our survey demonstrated the significant

impact faculty mentors have on the overall experience of undergraduate research for

students.

Future studies could expand the range of undergraduate research from the three

programs looked at in this study to include all undergraduate research being conducted on

campus. A comparison between formed, sponsored programs and other more informal

undergraduate research could provide insight to ways to maximize impacts of

undergraduate research as a whole. Furthermore, additional work is needed to determine

the effects of gender, ethnicity, academic preparedness, and number of undergraduate

research projects on a student's willingness to pursue STEM careers. Our intention is that the answers to these questions, combined with the results of this project, will support further institutional facilitation of undergraduate research through greater support of student stipends, research funding, and faculty incentives that could lead to a significant increase in BS recipients with professional science experience.

CHAPTER III

FACULTY MENTORS AND UNDERGRADUATE RESEARCH

3.1 Literature Review

Undergraduate research is becoming more commonplace on university campuses across the nation (Hunter et al., 2007). Correspondingly, a body of literature is developing which examines the impact of these programs on undergraduate participants (Hathway et al. 2002; Lopatto et al. 2004; Hunter et al. 2007; Russel et al. 2007; Howwit et al. 2009). However, these undergraduate research programs would not be possible without faculty engagement.

Although there are a number of motivating factors reported in the literature, a few are more commonly indicated by faculty as high ranking reasons for involvement in undergraduate research. Faculty often rated the desire to influence the career of developing students as the most important motivation for advising undergraduates in research (Zydney et al., 2002; Webber et al., 2012; Morrison et al., 2018). Morrison et al. (2018) also reported faculty mentors were invested in undergraduate research because they cared about future generations of scholars (87%) and enjoying mentoring students in research (86%). One of the lowest ranking motivators was found to be advancing their own research (68% and 50%; Morrison et al., 2018 and Zydney et al., 2002, respectively).

Faculty mentors commented on the meaningful and productive contributions of undergraduate students to their research program, specifically mentioning the student's willingness and desire to learn, commitment to the project, and the overall contribution to the research project (Adedokun et al., 2010). Zydney et al. (2002) reported 67% of surveyed faculty members rated student contribution to their research as important or very important, and 78% admitted that student involvement influenced their thinking about the research project. Hunter et al. (2007) determined formal contributions of their undergraduate students to the overall body of science as benefits for half of the faculty mentors, including presentations at conferences and co-authors on publications.

Interpersonal gains were also reported by faculty as a result of undergraduate research mentorship, including developing student-faculty professional relationships and inspiring and motivating developing science professionals as well as personal satisfaction from working with and watching the students experience their own personal and professional gains (Adedokun et al., 2010; Baker et al., 2015). Other benefits from leading undergraduate research reported by faculty include enjoyment from teaching students about research and preparing them for graduate school and positive performance reviews resulting from the research (Buddie et al., 2011). Faculty also benefit from extra assistance in the lab and from the "fearless creativity" of students (Chopin 2002).

Despite these benefits, many faculty still experience challenges that affect their decision to mentor undergraduates. The main challenge is that engagement in undergraduate research is time-consuming (Chopin 2002; Adedokun et al., 2010; Buddie et al., 2011; Baker et al., 2015; Morrison et al., 2018). Other challenge areas include: understanding the level of other responsibilities the students have in a given semester

(Adedokun et al. 2010) , measuring student experience in the research area (Adedokun et al. 2010), experiencing a lack of professional recognition for themselves and their students (Baker et al., 2015), and working with students that are underprepared and lack motivation (Adedokun et al., 2010; Buddie et al., 2011; Morrison et al., 2018). For example, Morrison et al. (2018) determined 37% of faculty viewed having unprepared students as a challenge, while Buddie et al. (2011) indicated faculty members rated underprepared students as a moderate barrier.

The importance of undergraduate research has been analyzed by measuring the skills undergraduate student researchers gain over the course of their research experience; however, other studies looked at faculty mentors' perceptions of their students' skill development. Most studies of faculty members agree that undergraduate students gain skills in working independently (Kardash, 2000; Zyndney et al., 2002), collecting data (Kardash, 2000; Cox & Andriot, 2009) relating to people of different backgrounds (Cox & Andriot, 2009), working in teams (Zydney et al., 2002; Cox & Andriot, 2009), and thinking critically (Zyndey et al., 2002; Hunter et al., 2007; Cox & Andriot, 2009; Buddie et al., 2011). Other gains by undergraduates reported by faculty are associated with intellectual curiosity, understanding of scientific findings, and open-mindedness about new ideas (Zydney et al., 2002). In contrast, lower gains in student achievement were reported by faculty regarding using literature, relating research to the bigger picture, and writing a published paper (Kardash, 2000; Cox & Andriot, 2009; Buddie et al., 2011). Hunter et al. (2007) found only 2% of surveyed faculty mentors reported an observed gain in their students' ability to identify new research questions and develop and/or test a hypothesis.

Previous research documents the importance of undergraduate research for both students and faculty throughout most of the United States, but not many studies have been conducted in the southeast, let alone in Mississippi . Mississippi State University (MSU) is a southeastern, land grant institution that is classified as a Carnegie Foundation Very High Research Activity doctoral university and is ranked by the National Science Foundation as a "Top 100" research university. The purpose of this study is to test whether benefits reported in the literature will be observed at a very high research, land-grant university that serves a diverse student body from states, including Mississippi, which are not known for high science achievement at the K-12 level (NAEP 2015). The purpose of this study is to analyze faculty members at MSU and determine their motivations to be involved in undergraduate research, the benefits and complications they may face, and the skills they see their undergraduates gaining throughout the research experience.

3.2 Methods

3.2.1 Participants

Names of faculty members who sponsored an undergraduate researcher were obtained from directors of the Undergraduate Research Scholarship Program (URSP) and the Officer of Research and Economic Development program. Contact information was gathered from MSU records and current email addresses were obtained for those that had left the university. At the time of the survey, faculty survey participants were located at Mississippi State University, Auburn University, Texas A&M University, North Carolina State University, and the State University of New York.

3.2.2   Survey Instrument

My faculty mentor survey instrument was based on surveys reported in published literature (Kardash 2000; Zydney et al., 2002; Hunter et al., 2007; Cox & Andriot, 2009; Buddie et al., 2011), and it included some additional questions I developed that were specific to the MSU programs. The survey included items relating to participants' academic status (department, tenure, and faculty rank), their undergraduate researcher projects, opinions on the benefits and/or challenges of undergraduate research, their perceptions of the personal & professional growth of the undergraduate student researchers, and their future intentions to mentor additional undergraduate students (see Appendix B for survey instrument). Participants were also asked to rank the potential risk factors associated with decisions to mentor an undergraduate student researcher on a Likert scale of 1 to 5 (1-not important, 2-minimally important, 3-moderately important, 4-important, 5-very important).

The survey was approved by MSU's Institutional Review Board (project approval number, IRB-8-487). The survey was developed in Qualtrics® (Qualtrics, Provo, UT), an online survey platform, and distributed via an emailed link. Following the initial request in February, 2019, a reminder was sent out at 2-weeks post initial email.

3.3 Results

One hundred and twenty-two participants were contacted for the faculty mentor survey, and 71 people responded; however, only 63 participants filled out the survey completely. This resulted in a response rate of 58% and a completion rate of 52%.

Faculty participants conducted research in 17 different departments (Table 3.1). On average, participants mentored 3 students, with 17% of participants having mentored 6 or more students. Sixty two percent of participants were currently conducting research with an undergraduate student researcher at the time of the survey, and 96% plan on working with more undergraduate student researchers in the future. Fifty-five percent of participants received grants from the College of Arts and Life Sciences URSP programs, 28% from the ORED UR program, and 17% from the College of Forest Resources URSP program.   At the time they were sponsoring undergraduate student researchers, 54% percent of participants were assistant professors, 30% were associate professors, and 14% were full professors. Forty-nine percent of participants had not received tenure at the time of their research, 38% had already achieved it, and 14% were on a nontenure track. Nearly half (45%) of faculty mentors reported spending 1-2 hours per week working with their undergraduate student researcher. An additional 31% indicated 3-4 hour weekly commitment and 16% spent 5-6 hours per week in mentoring undergraduates in research.

As was seen in the published literature, a majority of MSU faculty survey participants rated the desire to influence careers of talented undergraduate student researchers and the opportunity to contribute to their own research programs as the most important considerations in deciding to involve undergraduates in their research (Table 3.2)

Table 3.1 MSU Departments and number of faculty mentors from each department

MSU Department of Academic Appointment	Number
Agriculture and Biomedical Engineering	3
Agricultural Economics	7
Animal and Dairy Sciences	8
School of Architecture	1
Biochemistry, Molecular Biology, Entomology, and Plant Pathology	11
Biological Sciences	1
Communication	1
Food Science, Nutrition, and Health Promotion	2
Forestry	4
Geosciences	1
History	1
School of Human Sciences	5
Physics	1
Plant and Soil Sciences	5
Poultry Sciences	1
Sociology	1
Wildlife, Fisheries and Aquaculture	10
Other	8

Table 3.2 Faculty considerations in deciding to mentor undergraduate researchers

Considerations in working with Undergraduates	Mean Rating of Importance[1]
Desire to influence the career of talented undergraduate students	4.7
Opportunity to contribute to your own research program	3.6
Opportunity to contribute to your quality of life at the university	3.0
Departmental encouragement to participate in undergraduate research	2.9

[1]Rated on a 1-5 Likert scale (1-not important; 2-slightly important; 3-moderately important; 4-important; 5-very important)

Time and research reliability were the most influential risk factors for participants in deciding to work with undergraduate student researchers (Table 3.3). These categories were rated as important or very important by 55% and 58% of participants, respectively. Resource costs also played a role, with 41% of participants rating this factor as important or very important. Departmental expectations was the lowest influential factor, with 55% of participants rating it as not important or slightly important.

Table 3.3 Risk factors for faculty in deciding to work with undergraduate research

students

Risk Factors	Mean Rating of Importance[1]
Time	3.6
Research reliability of students	3.6
Resource costs	3.1
Departmental expectations	2.4

[1]Rated on a 1-5 Likert scale (1-not important; 2-slightly important; 3-moderately important; 4-important; 5-very important)

Faculty perceptions of the benefits of undergraduate student research may not be

the same as that reported by undergraduates (Chapter Two). The most important skills

faculty believe students gained through their undergraduate research experience were

understanding of research methods and critical thinking (Table 3.4), both rated as an

important or very important benefit by 86% of participants (n=64). Leadership and data

analysis were deemed least impacted by students' undergraduate research experience.

Participants were also asked to indicate what undergraduate student researchers

gain from the research process that differs from those that do no have this experience.

The most frequent responses were related to the opportunity to learn what conducting

research is truly like, and faculty noted the applications of these benefits to graduate

school and careers (Table 3.5).

Table 3.4 Skills undergraduates gained through undergraduate research according to faculty mentors

Skill	Mean Ranking[1] of Research Impact on Skill Development
Understanding of research methods	4.4
Critical thinking skills	4.4
Independent learning skills	4.3
Self-confidence	4.3
Intellectual curiosity	4.3
Meaningful relationships with professional mentors	4.3
Adaptability and tolerance of obstacles	4.2
Understanding of ethical research conduct	4.2
Interpretation of research results	4.2
Oral presentation skills	4.1
Readiness for more demanding research	4.1
Understanding of how knowledge is constructed	4.1
Skills in following directions/instructions	4.0
Creativity	4.0
Skills and knowledge of lab and/or research techniques	4.0
Listening skills	4.0
Scientific writing skills	3.9
Integration of theory and practice	3.8
Understanding of primary literature	3.8
Data analysis	3.7
Leadership skills	3.6

[1] Rated on a 1-5 Likert scale (1=not important; 2=slightly important; 3=moderately important; 4=important; 5=very important)

Table 3.5 Differences between undergraduate students with research and those without as reported by faculty mentors.

Benefits to undergraduates in research	Frequency
What conducting research/science is really like	22
Idea of what graduate school is like	11
Self-confidence	6
Relating class material to research	4
Hands on experience with professional equipment	4
Critical thinking	4
Networking/professional development	4
Understanding other commitments of faculty	3
Public speaking skills	2
Problem solving skills	2
Independence	2

Faculty survey participants were asked to indicated the most difficult aspects of the undergraduate research process for undergraduate student researchers (Table 3.6). The most commonly reported answers related to time commitment, writing abilities, analysis and statistics skills, conducting literature reviews, and critical thinking.

Table 3.6 Areas of difficulty for undergraduate researchers as reported by faculty mentors.

Aspect	Frequency
Writing	14
Time devoted to research	14
Statistics/analysis	7
Literature reviews	6
Thinking critically	5
Lack of knowledge and preparation	5
Learning software and skills	3
Lack of attention to detail	3
Communication of research results	3
Interpretation of data results	2
What research actually is	2
Research not going as planned	2
Developing research questions	2
Transfer from classroom to research	2

3.4 Discussion

      This work has been the first look at faculty mentors' perceptions of undergraduate research at MSU. We found that a majority of participants have worked or want to work with undergraduate students in their research field. Those who plan to work with more students gave a brief explanation of why they would like to do so. Some participants focused on the benefits for the students:

      "It is important to provide research opportunity so that students can apply their education to real problems and gain practical experience in the sciences."

      "The potential for personal and professional growth with these talented and driven individuals is quite high. It is inspiring to see UGR students thrive!"

Other faculty survey participants have had positive experiences in the past and would like to continue working with undergraduates. However, some participants have had poor experiences with undergraduate students working in their lab and are therefore hesitant to have any more in the future. One participant stated that the reward from having an undergraduate student in the lab did not balance out with the effort placed into the overall project.   According to this participant, "it would take an extraordinary student to try again."

      This project also showed the most common motivating factors for faculty mentors when deciding to work with an undergraduate student researcher. Many of our findings

are consistent with past research. We determined that most participants are motivated by their desire to influence the career of talented undergraduate students (Zydney et al., 2002; Webber et al., 2012; Morrison et al., 2018). However, the opportunity to contribute to their own research programs was ranked one of the highest motivating factors by faculty survey participants in this survey but ranked lowest in other studies (Morrison et al., 2018; Zydney et al., 2002). As to why that is, we cannot say for sure. It can possibly have something to do with the quality of undergraduate research at different universities or the varying impacts undergraduate researchers have on the final results of the research project.

Furthermore, we determined the main risk factors for faculty when deciding to work with undergraduate students. As in other studies, time commitment was found to be the main challenge faculty survey participants face (Chopin 2002; Adedokun et al., 2010; Buddie et al., 2011; Baker et al., 2015; Morrison et al., 2018). Another risk was in research reliability, or working with underprepared, unreliable students (Adedokun et al., 2010; Buddie et al., 2011). Nevertheless all of the risks were rated below or slightly above average, so no one category represented a risk shared by an overwhelming majority of the faculty survey participants.

We also identified the most difficult aspects of learning the research process for undergraduate students, according to their faculty mentors. Although not much literature was found that included this question, faculty participants of this survey provided explanations of the difficulties they believe undergraduates face and why they think that is.

"Thinking critically and understanding the implications of the projects… The students I have had work for me clearly understand the research activities they are tasked with… the harder part is to get them to understand the results of their data and how to get through the next step of disseminating their research."

"Reading the literature and understanding what has already been accomplished… We live in a publication rich time meaning that it is very easy to get behind on the current literature…. most students do not read enough scientific literature to keep up with the times."

Furthermore, participants rated the importance of the skills they believe undergraduate research students developed during their undergraduate research. Our results support those found in previous literature. We determined that understanding of research methods (Zydney et al., 2002) and critical thinking (Zyndey et al., 2002; Hunter et al., 2007; Cox & Andriot, 2009; Buddie et al., 2011) were the two most important skills faculty believed students developed. Other skills included independent learning skills (Kardash, 2000; Zyndney et al., 2002) and teamwork skills (Zydney et al., 2002; Cox & Andriot, 2009). While leadership and data analysis were rated as the least important skills, they were still rated well above average importance, meaning that out of the twenty-one skills listed, faculty participants believed everyone one of them was at least somewhat important in the development of the undergraduate student during their undergraduate research experience.

3.5 Conclusion

This project identified the main motivating factors for faculty at MSU in deciding to work with undergraduates, the risks they face as a result of working with students, the most difficult aspects of learning the research process for students, the difference in skills developed between students who pursue undergraduate research and those that do not, and the importance of the skills they believe undergraduate student researchers develop as a result of the research experience. Through faculty feedback, we were able to expand why faculty members included certain responses, such as why literature reviews are such a difficult aspect of research for students.

Future studies could look at the relationship between gender, status of professorship, level of tenure, and amount of students mentored to determine if any of these factors play a part on a faculty member's willingness to work with undergraduate student researchers. Furthermore, an analysis of the benefits faculty mentors believe they receive from undergraduate research, as well as possible incentives that could encourage them to engage undergraduate students in their work, could also help further develop these research programs and increase the number of student researchers across campus. Our intention is that the answers to these questions, combined with the results of the project, will support further institutional facilitation of faculty members working with students through an increase in funding, programs, benefits, and incentives that could lead to a significant increase in the amount of undergraduates with professional science experience

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APPENDIX A

STUDENT SURVEY ON THE EFFECTS OF UNDERGRADUATE RESEARCH

Evaluating the Impacts of Undergraduate Research Programs at Mississippi State University for Developing Science Professionals

Hello,

My name is Isabella Durham, and I am an undergraduate at Mississippi State University. I am conducting a research project called, *Evaluating the Impacts of Undergraduate Research Programs at Mississippi State University for Developing Science Professionals* (Protocol ID: IRB-18-487). My faculty mentor, Leslie Burger, and I would like to learn more about the impact of undergraduate research programs. We are particularly interested in whether these programs improve participants' educational experience, enhance retention of talented students in science careers, or lead to discovery of new information.

We would like to ask you to voluntarily participate in our research study. If you choose to participate, you will be asked to complete a survey that will take about 15 minutes to finish. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue your participation at any time without penalty or loss of benefits. Answers to the survey are anonymous and no identifiable information is recorded. You are free to exit the survey at any time. If you decide to participate in the survey, your participation indicates your consent. Please print this page for your records.

 If you have any questions about this research project, please feel free to contact me, Isabella Durham, at id113@msstate.edu or Dr. Leslie Burger at leslie.burger@msstate.edu. By clicking yes, you agree that you have read the above information and wish to participate in the following survey. If you click no, the survey will not begin.

- ○ Yes (1)
- ○ No (2)

2. Gender

- ○ Male (1)

- ○ Female (2)

- ○ I prefer not to answer (3)

3. Ethnicity

- ○ White (1)

- ○ Hispanic (2)

- ○ Black/African American (3)

- ○ Native American/Indian (4)

- ○ Asian/Pacific Islander (5)

- ○ Other (6)

- ○ I prefer not to answer (7)

4. Age range

- ○ 17-22 (1)

- ○ 23-28 (2)

- ○ >28 (3)

5. What is/was your home Department (location of your major) at Mississippi State University?

- ○ Agriculture and Biological Engineering (1)

- ○ Agriculture Economics (2)

- ○ Animal and Dairy Sciences (3)

- ○ (School of) Architecture (4)

- ○ Art (5)

- ○ Biochemistry, Molecular Biology, Entomology and Plant Pathology (6)

- ○ Biological Sciences (7)

- ○ Chemistry (8)

- ○ Communication (9)

- ○ Computer Science and Engineering (10)

- ○ Curriculum, Instruction and Special Education (11)

- ○ Food Science, Nutrition and Health Promotion (12)

- ○ Forestry (13)

- ○ Geosciences (14)

- ○ History (15)

- ○ (School of) Human Sciences (16)

- ○ Industrial and Systems Engineering (17)

- ○ Kinesiology (18)

- ○ Landscape Architecture (19)

- ○ Mechanical Engineering (20)

- ○ Physics (21)

- ○ Plant and Soil Science (22)

- ○ Poultry Science (23)

- ○ Sociology (24)

- ○ Sustainable BioProducts (25)

- ○ Wildlife, Fisheries and Aquaculture (26)

- ○ Other. (27) _____

6. What is your current academic status?

- ○ Student in a bachelor's degree program (1)

- ○ Student in a master's degree program (2)

- ○ Student in a PhD program (3)

- ○ Student in a professional degree program (DVM, medical, etc.) (4)

- ○ Employed, research-related career field (5)

- ○ Employed, non-research-related career field (6)

- ○ Other. (7) _____

7. In how many undergraduate research projects have you participated in at Mississippi State?

- ○ 1 (1)

- ○ 2 (2)

- ○ 3 (3)

- ○ 4 (4)

○   5 (5)

*8. Describe your undergraduate research experience including a title for the project and when it was conducted.

_____
_____
_____
_____
_____

9. In what Department is/was your undergraduate research based?

    ○ Agriculture and Biological Engineering (1)

    ○ Agricultural Economics (2)

    ○ Animal and Dairy Sciences (3)

    ○ (School of) Architecture (4)

    ○ Art (5)

    ○ Biochemistry, Molecular Biology, Entomology, and Plant Pathology (6)

    ○ Biological Sciences (7)

    ○ Chemistry (8)

    ○ Communication (9)

    ○ Computer Science and Engineering (10)

    ○ Curriculum, Instruction and Special Education (11)

    ○ Food Science, Nutrition and Health Promotion (12)

    ○ Forestry (13)

    ○ Geosciences (14)

    ○ History (15)

    ○ (School of) Human Sciences

o Industrial and Systems Engineering (17)

o Kinesiology (18)

o Landscape Architecture (19)

o Mechanical Engineering (20)

o Physics (21)

o Plant and Soil Sciences (22)

o Poultry Science (23)

o Sociology (24)

o Sustainable BioProducts (25)

o Wildlife, Fisheries and Aquaculture (26)

o Other (27)_____

10. Was your undergraduate research sponsored by the university through a small grant program?

o   Yes (1)

o   No (2)

o   Not sure (3)

11. Did you receive wages or payment for the undergraduate research you conducted?

o   Yes (1)

o   No (2)

12. My primary research supervisor was a...

o   faculty member (1)

o   post-doctoral student (2)

o   graduate student (3)

o   lab technician/research associate (4)

o   other (5) _____

13. Do you maintain contact with the faculty member with whom you conducted this undergraduate research?

- o Yes, I am still conducting the research (1)

- o Yes, even though I am done conducting the research (2)

- o No, I am no longer in contact with the project's faculty mentor (3)

14. Did you present outcomes of this undergraduate research project at a professional meeting or conference?

- o Yes (1)

- o No (2)

Skip To: Q17 If Did you present outcomes of this undergraduate research project at a professional meeting or conf... = No

15. At what type of professional meeting or conference did you present this undergraduate research ? Select all that apply.

☐ University meeting/conference (1)

☐ State meeting/conference (2)

☐ Regional meeting/conference (3)

☐ National meeting/conference (4)

☐ International meeting/conference (5)

☐ Other. Please specify. (6) _____

16. What was the format of this undergraduate research presentation? Select all that apply.

- Oral (1)

- Poster (2)

- Other (3) _____

17. Did you present this undergraduate research at an MSU-sponsored research symposium, such as the Shackouls Honors College Undergraduate Research Symposium?

- Yes (1)

- No (2)

18. What was the format of your undergraduate presentation for the MSU-sponsored research symposium? Select all that apply.

- Oral (1)

- Poster (2)

- Other. Please specify (3)
  _____

19. Did you publish the outcomes of this undergraduate research project?

- Yes (1)

- No (2)

20. Where did you publish the outcomes of your undergraduate research? Check all that apply.

☐ Conference proceedings (1)

☐ Peer-reviewed journal (2)

☐ Non-peer-reviewed journal (3)

☐ Popular or non-peer-reviewed publication (4)

☐ Other. Please Specify. (5) _____

21. Please type the citation for any publication(s) that resulted from this undergraduate research.

_____
_____
_____
_____
_____

22. If you have not yet published the outcomes of your undergraduate research, where are you in the publishing process?

○ There are no plans for publication of these research outcomes. (1)

○ The manuscript is not started but there are plans for publication. (2)

○ The manuscript is in progress. (3)

○ The manuscript has been submitted. (4)

○ The manuscript is in review (5)

○ NA (7)

Questions 8-22 were repeated based on the answer to #7. For example, if the student had conducted 2 undergraduate research projects, 8-22 would be repeated once more.

23. What are your plans regarding graduate/professional school?

- ○ I do not plan on attending graduate/professional school. (1)

- ○ I am planning on attending graduate/professional school. (2)

- ○ I am currently in graduate/professional school. (3)

- ○ I have graduated from graduate/professional school. (4)

- ○ Other (5)

24. Did your undergraduate research experience influence your plans for postgraduate education?

- ○ My undergraduate research experience confirmed the plans I already had for graduate education. (1)

- ○ My undergraduate research experience changed my prior plans so that **I am now considering** graduate education. (2)

- ○ My undergraduate research experience changed my prior plans so that **I am no longer considering** graduate education. (3)

- ○ I still have no plans for graduate education. (4)

25. How important were the following considerations in your decision to pursue undergraduate research?

	Not important at all (1)	Minimally important (2)	Moderately important (3)	Important (4)	Very important (5)
I wanted to expand my understanding of research. (1)	○	○	○	○	○
I wanted to work with a particular faculty member. (2)	○	○	○	○	○
I wanted to make some additional money. (3)	○	○	○	○	○
I am required by a scholarship or other academic requirement to pursue undergraduate research. (4)	○	○	○	○	○
I wanted to gain experience for future education/jobs. (5)	○	○	○	○	○

26. Please rate your level of science readiness in the following areas prior to and after your undergraduate research experience.

	Professional science readiness BEFORE undergraduate research					AFTER undergraduate research				
	None (1)	Minimal (2)	Average (3)	Above average (4)	Excellent (5)	None (1)	Minimal (2)	Average (3)	About Average (4)	Excellent (5)
Understanding of the research process (1)	○	○	○	○	○	○	○	○	○	○
Understanding of how knowledge is constructed (2)	○	○	○	○	○	○	○	○	○	○
Integration of theory and practice (3)	○	○	○	○	○	○	○	○	○	○
Understanding of ethical research conduct (4)	○	○	○	○	○	○	○	○	○	○
Understanding of primary literature (5)	○	○	○	○	○	○	○	○	○	○
Skills and knowledge of lab and/or research techniques (6)	○	○	○	○	○	○	○	○	○	○
Skills in following directions/instructions (7)	○	○	○	○	○	○	○	○	○	○

Data analysis (8)	○	○	○	○	○	○	○	○	○	○
Interpretation of research results (9)	○	○	○	○	○	○	○	○	○	○
Meaningful relationships with professional mentors (10)	○	○	○	○	○	○	○	○	○	○
Credibility with faculty members and colleagues (11)	○	○	○	○	○	○	○	○	○	○
Membership within the learning and/or scientific community (12)	○	○	○	○	○	○	○	○	○	○
Readiness for more demanding research (13)	○	○	○	○	○	○	○	○	○	○
Self-confidence (14)	○	○	○	○	○	○	○	○	○	○
Toleration of obstacles (15)	○	○	○	○	○	○	○	○	○	○
Listening skills (16)	○	○	○	○	○	○	○	○	○	○
Oral presentation skills (17)	○	○	○	○	○	○	○	○	○	○
Scientific writing skills (18)	○	○	○	○	○	○	○	○	○	○

Independent learning skills (19)	○	○	○	○	○	○	○	○	○	○
Leadership skills (20)	○	○	○	○	○	○	○	○	○	○
Critical thinking skills (21)	○	○	○	○	○	○	○	○	○	○
Teamwork skills (22)	○	○	○	○	○	○	○	○	○	○

27. Please rate your responses to the following statements about your undergraduate research experience.	Strongly disagree (1)	Disagree (2)	Neither agree or disagree (3)	Agree (4)	Strongly agree (5)
The research I conducted was interesting and challenging. (1)	○	○	○	○	○
There were new and interesting results from the research. (2)	○	○	○	○	○
I enjoyed being part of a team and contributing to that team. (3)	○	○	○	○	○
I learned many valuable skills. (4)	○	○	○	○	○
I worked independently. (5)	○	○	○	○	○
I was given the opportunity to learn from my mistakes. (6)	○	○	○	○	○
The supervisor was friendly and approachable. (7)	○	○	○	○	○
I had adequate support from my supervisor. (8)	○	○	○	○	○
My research supervisor was enthusiastic. (9)	○	○	○	○	○

My supervisor provided expert guidance. (10)	○	○	○	○	○
I worked on a well-designed project. (11)	○	○	○	○	○
I was able to relate my research to real world problems. (12)	○	○	○	○	○
I was able to network with faculty, peers, and others in my research field. (13)	○	○	○	○	○
Undergraduate research enhanced my career preparation. (14)	○	○	○	○	○

28. Did you encounter difficulties during your undergraduate research experience? Please respond to the following statements.

	NO (0)	YES (1)
Frustrating (1)	○	○
Slow Moving (2)	○	○
Complex (3)	○	○
Ambiguous (4)	○	○

29. Did you encounter difficulties during your undergraduate research experience? Please respond to the follow questions.

	NO (1)	YES (2)
Things going wrong with the experiment? (1)	○	○
Equipment breakdown/failure? (2)	○	○
Time management issues? (3)	○	○
Conflicts with the advisor/supervisor? (4)	○	○

30. Do you think your race and/or gender affected you undergraduate research experience?

Please explain.

_____
_____
_____
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APPENDIX B

FACULTY SURVEY ON THE EFFECTS OF UNDERGRADUATE RESEARCH

Evaluating the Impacts of Undergraduate Research at Mississippi State University for Developing Science Professionals

Q1 Hello. My name is Isabella Durham, and I am an undergraduate at Mississippi State University. I am conducting a research project called, *Evaluating the Impacts of Undergraduate Research Programs at Mississippi State University for Developing Science Professionals* (Protocol ID: IRB-18-487). My faculty mentor, Leslie Burger, and I would like to learn more about the impact of undergraduate research programs on faculty participants as well as the undergraduates with whom they work.

We would like to ask you to voluntarily participate in our research project. If you choose to participate, you will be asked to complete a survey that will take about 12 minutes to finish. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue your participation at any time without penalty or loss of benefits. Answers to the survey are anonymous and no identifiable information is recorded. You are free to exit the survey at any time. If you decide to participate in the survey, your participation indicates your consent. Please print this page for your records.
If you have any questions about this research project, please feel free to contact me, Isabella Durham, at id113@msstate.edu or Dr. Leslie Burger at leslie.burger@msstate.edu.

By clicking yes, you agree that you have read the above information and wish to participate in the following survey. If you click no, the survey will not begin.

By clicking yes, you agree that you have read the above information and wish to participate in the following survey. If you click no, the survey will not begin.

- ○ Yes, I will take the survey (1)

- ○ No, thank you (2)

Skip To: End of Survey If By clicking yes, you agree that you have read the above information and wish to participate in th... = No, thank you

2. In what Department or School at Mississippi State University is/was your faculty appointment?

- ○ Agriculture and Biological Engineering (1)

- ○ Agricultural Economics (2)

- ○ Animal and Dairy Sciences (3)

- ○ (School of) Architecture (4)

- ○ Art (5)

- ○ Biochemistry, Molecular Biology, Entomology, and Plant Pathology (6)

- Biological Sciences (7)

- Chemistry (8)

- Communication (9)

- Computer Science and Engineering (10)

- Curriculum, Instruction and Special Education (11)

- Food Science, Nutrition and Health Promotion (12)

- Forestry (13)

- Geosciences (14)

- History (15)

- (School of) Human Sciences (16)

- Industrial and Systems Engineering (17)

- Kinesiology (18)

- Landscape Architecture (19)

- Mechanical Engineering (20)

- Physics (21)

- Plant and Soil Sciences (22)

- Poultry Science)

- Sociology (24)

- Sustainable Bioproducts (25)

- Wildlife, Fisheries and Aquaculture (26)

- Other (27) _____

3. In what University-sponsored undergraduate research programs have you participated during the 2013-2019 period? Check all that apply.

☐ FWRC/CFR Undergraduate Research Scholars Program (1)

☐ MAFES/CALS Undergraduate ResearchScholars Program (2)

☐ ORED Undergraduate Research Program (3)

4. How many undergraduate student researchers have you supervised in the past 6 years (2013-2019) as part of MSU-sponsored undergraduate research programs?

○ 1 (1)

○ 2 (2)

○ 3 (3)

○ 4 (4)

○ 5 (5)

○ 6 or more (6)

5. Are you currently conducting research with an undergraduate student as part of a MSU-sponsored undergraduate research program (ORED, MAFES/CALS, or FWRC/CFR) ?

○ Yes (1)

○ No (2)

Skip To: Q2.6 If Are you currently conducting research with an undergraduate student as part of a MSU-sponsored un... = No

6. Which MSU undergraduate research program is funding your current undergraduate research? Check all that apply.

☐ FWRC/CFR Undergraduate Research Scholars Program (1)

☐ MAFES/CALS Undergraduate Research Scholars Program (2)

☐ ORED Undergraduate Research Program (3)

7. Are you currently conducting research in collaboration with an undergraduate student that is supported by funds <u>other than</u> those from ORED, MAFES/CALS, or FWRC/CFR undergraduate research programs?

○ Yes, the student and project are supported by another internal-funding source. (1)

○ Yes, the student and project are supported by an external-funding source. (2)

○ No (3)

8. Are you planning on working with more undergraduate student researchers in the future? (Choose one)

○ Yes, I plan on working with additional undergraduate researchers at Mississippi State University. (1)

○ Yes, I plan on working with undergraduates researchers at another institution. (2)

○ No, I do not plan on working with any more undergraduate researchers. (3)

9. Why did you make this decision regarding future work with undergraduate student researchers ?

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10. What is/was your faculty rank at Mississippi State University when you served as a faculty mentor in an MSU-sponsored undergraduate research program? Select all that apply.

☐ Assistant professor (1)

☐ Associate professor (2)

☐ Professor (3)

☐ other (4) _____

11. What was your status with regard to tenure when you were participating as a faculty mentor in an MSU undergraduate research program? Select all that apply.

☐ I had not yet achieved tenure. (1)

☐ I had already achieved tenure. (2)

☐ I am/was not in a tenure-track position. (3)

12. How many scientific journal articles did you publish with your MSU-sponsored undergraduate student researcher(s) as co-author(s)?

○ 0 (1)

○ 1(2)

○ 2 (7)

○ 3(3)

○ 4(4)

○ 5(5)

○ 6 or more (6)

13. Please type the citation(s) for the scientific journal article(s) that resulted from your undergraduate research projects sponsored by MSU.

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14. On a scale of 1 to 5, 1 being not important at all and 5 being very important, how important are the following considerations in your decision to involve undergraduates in your research?

	1=not important (1)	2=slightly important (2)	3=moderately important (3)	4=important (4)	5=very important (5)
Desire to influence the career of talented undergraduate students (1)	○	○	○	○	○
Opportunity to contribute to your own research program (2)	○	○	○	○	○
Departmental encouragement to participate in research with undergraduate students (3)	○	○	○	○	○
Opportunity to contribute to your quality of life at the university (4)	○	○	○	○	○

15. How do/did you select undergraduate student researchers?

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16. On a scale of 1 to 5, 1 being not important at all and 5 being very important, how influential are these potential risk factors when deciding to mentor an undergraduate student researcher?

	1= not important (1)	2=slightly important (2)	3=moderately important (3)	4=important (4)	5=very important (5)
Time (diversion of time from research, instruction or other work expectations). (1)	○	○	○	○	○
Departmental expectations (e.g, view of undergraduate research vs graduate or individual vs classroom instruction). (2)	○	○	○	○	○
Resource costs (diversion of research resources that could be applied elsewhere). (3)	○	○	○	○	○
Research reliability (question of work quality from undergraduates). (4)	○	○	○	○	○

17. On average, how many hours per week do you spend supervising or mentoring <u>each</u> undergraduate researchers?

- ○ 1-2 hours/week (1)
- ○ 3-4 hours/week (2)
- ○ 5-6 hours/week (3)
- ○ 7-8 hours/week (4)
- ○ 9-10 hours/week (5)
- ○ >10 hours/week (6)

18. What are the most difficult aspects of learning the research process for students? Why do you think this is?

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19. What procedures and/or resources do you use to support training and mentoring of undergraduate student researchers?

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20. If on-campus training on working effectively with undergraduate student researchers was made available to faculty, would you participate?

- ○ Yes (1)
- ○ No (2)

21. What do you like to see in a student and their work that tells you that their research experience has been successful?

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22. How do you evaluate their work/progress and then communicate this to the student?

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23. On a scale of 1 to 5, 1 being not important at all and 5 being very important, how important do you think the undergraduate research you directed was to the students'/students' development in the following areas:	1=not important (1)	2=minimally important (2)	3=moderately important (3)	4=important (4)	5=very important (5)
Understanding of research methods (1)	○	○	○	○	○
Understanding of how knowledge is constructed (2)	○	○	○	○	○
Integration of theory and practice (3)	○	○	○	○	○
Understanding of ethical research conduct (4)	○	○	○	○	○
Understanding of primary literature (5)	○	○	○	○	○
Skills and knowledge of lab and/or research techniques (6)	○	○	○	○	○
Skills in following directions/instructions (7)	○	○	○	○	○

Data analysis (8)	○	○	○	○	○
Interpretation of research results (9)	○	○	○	○	○
Meaningful relationships with professional mentors (10)	○	○	○	○	○
Readiness for more demanding research (11)	○	○	○	○	○
Intellectual curiosity (12)	○	○	○	○	○
Creativity (13)	○	○	○	○	○
Self-confidence (14)	○	○	○	○	○
Adaptability and tolerance of obstacles (15)	○	○	○	○	○
Listening skills (16)	○	○	○	○	○
Oral presentation skills (17)	○	○	○	○	○

Scientific writing skills (18)	○	○	○	○	○
Independent learning skills (19)	○	○	○	○	○
Leadership skills (20)	○	○	○	○	○
Critical thinking skills (21)	○	○	○	○	○
Teamwork skills (22)	○	○	○	○	○

24. In your opinion, what do undergraduate student researchers gain from this process that differs from those that do not have this experience?

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25. In your experience, do you think the impacts of the undergraduate research experience are any different for female students or students of color than for male or white/Caucasian undergraduate students? Please explain your response.

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26. Is there anything else you would like to add about your experience with MSU-sponsored undergraduate research programs?

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