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The Genesis, Evolution, and Influence of Undergraduate Research Mentoring Relationships

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Keywords

mentoring; undergraduate research; student-faculty relationships; student development

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The Genesis, Evolution, and Influence of Undergraduate Research Mentoring Relationships

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Abstract

Undergraduate research has been documented as yielding valuable student learning outcomes. While the outcomes have been extensively investigated, the development and characteristics of the relationship with the research mentor has received less attention. To better understand how participating in undergraduate research yields substantial benefits to students, we need to elucidate the relationship between students and their research mentors. Using survey and focus group data from a select group of undergraduate researchers at one research university, we investigated the origins of undergraduate research mentoring relationships, the development of those relationships over time, and how the characteristics of the mentoring relationship yielded a shift in identity among the undergraduates. In this case study we found that the meaningful relationships developed between students and their mentors contributed to student development in the form of increased confidence and perceived competency. This competency led to changed expectations of self in the professional sphere, a deeper sense of belonging, and changed expectations for post-graduation.

INTRODUCTION

Undergraduate research (UR) is a well-studied, high impact practice in contemporary higher education and ample scholarship focuses on the substantial personal and professional benefits that accrue to students who participate (Girves et al., 2005; Kuh, 2008; Lopatto, 2010). Evidence is clear that students who engage in UR are more successful (across many definitions of success) than are students who do not participate, and those benefits accrue more substantially to students from underrepresented groups (Kinkead, 2003; Linn et al., 2015; Lopatto, 2004, 2010). What is less clear is the specific mechanism by which these outcomes arise. In this paper, we describe a case-study of the mentoring relationship at one Carnegie designated R1 Doctoral University characterized by the highest research activity, lending insight into this important component of the UR experience. Specifically, we aim to clarify the pathways by which mentoring relationships form, the manner in which they evolve over time, and the role they serve in student development.

The relationship between a student and his/her research mentor is emerging as a significant component in student development outcomes related to UR (Bhattacharyya et al., 2018; Davis & Jones, 2017; Johnson et al., 2015; Kinkead, 2003). Exploring the relationship between mentoring, undergraduate research and identity development, Palmer and colleagues describe the complicated overlap of these constructs and their dynamic nature (Palmer et al., 2015). Furthermore, previous findings identify a wide range of important early adult life outcomes are predicted by measures of social emotional, but not academic, competence (Martins et al., 2010; Singh & Sharma, 2012). A developing body of scholarship also indicates that college students with higher social and emotional competence tend to have stronger social support networks, more positive social relationships with peers and faculty, better academic performance, and more advanced decision-making skills than their less skilled counterparts (Lopes et al., 2005). Thus, the connection between the mentoring relationship and student outcomes is worthy of analysis.

Undergraduate research provides significant value for the students who participate, including increased retention and graduation rates and graduate school enrollment (Girves et al., 2005; Kuh, 2008; Lopatto, 2010). UR has been shown to better prepare students for their future careers and graduate study (Behar-Horenstein et al., 2010; Craney et al., 2011; Felder, 2010; Healey & Jenkins, 2009; Hu et al., 2007; Hunter et al., 2007; Laursen, 2010; Lei & Chuang, 2009; Levenson, 2010; Lopatto, 2010; Osborn & Karukstis, 2009; Potter et al., 2009; Seymour et al., 2004) and is an integral part in helping students becoming professionals (Hunter et al., 2007; Laursen, 2010; Lopatto, 2010; Seymour et al., 2004; Wilson et al., 2012). This critical transformation is a form of disciplinary socialization, wherein students learn the habits of mind and are welcomed into the community of scholars in their field (Boyer, Braxton, Ream, & Moser, 2016; Chubin & Ward, 2009; Gentile, 2007; Merkel, 2003; Merkel & Baker, 2002). Chapman (2003) described this socialization as a form of role-playing, in that “undergraduates can learn the conventions of research through imitation and practice” (p. 2). He further posited that engaging undergraduates in scholarship is “an essential part of the internal transformation that takes place as a student begins to understand what it means to be a scholar and a researcher” (Chapman, 2003, p. 2). Through UR experiences, students learn the skills necessary to succeed after graduation (Crowe, 2006; Hu, Scheuch, Schwartz, Gayles, & Li, 2008; Merkel, 2003). Undergraduates who engage with a faculty mentor with respect to a scholarly project during their college years have better grades, demonstrate higher retention rates, and describe their college or university educational experience more positively than their un-mentored undergraduate peers (Eby et al., 2008; Gershenfeld, 2014; Lopatto, 2010; Seymour et al., 2004). Mentored UR students have increased opportunities to learn how knowledge is created (Cole, 2007) and have access to faculty and peers that they may not otherwise have (Childress et al., 2009). These benefits are particularly salient for underrepresented minority students (Blake-Beard et al., 2011; Gershenfeld, 2014), who, as a group, have been found to be less confident in their academic abilities and as

less likely than their counterparts to engage faculty both inside and outside of the classroom (Soria & Stebleton, 2012). Indeed, compared to advising or other types of university mentoring relationships, UR mentoring relationships are deeper and more likely to be sustained beyond academic and career counseling (Johnson et al., 2015; Kinkead, 2003). Undergraduate student research mentees often see additional growth in their discipline-specific competencies, identities as scholars, and pathways to alternative professional paths (Barnett, 2008; Behar-Horenstein et al., 2010; Crowe, 2006; Levenson, 2010; Seymour et al., 2004).

Considering these profound and significant benefits of working directly with a faculty mentor on a scholarly project, research is limited on what specific practices and behaviors are most successful when mentoring an undergraduate. In a recent review of 60 empirical studies of undergraduate research experiences, Linn and colleagues (2015) described the significance of the mentor in promoting positive outcomes for the student. The authors observed that “mentors rarely receive guidance about how best to mentor undergraduates” and that “the field would benefit from research that identifies mentoring practices” (Linn et al., 2015). Using a qualitative approach, this study aims to address this deficit by examining the origins, evolution, and character of the UR mentoring relationship and by describing how these important relationships influence student development. Therefore, our specific research questions are as follows. First, what are the pathways into UR mentoring relationships? Second, how do UR mentoring relationships change across the life course of the relationship? And finally, how does the nature of the UR mentoring relationship specifically shape the development of students’ identities as researchers? Understanding the answers to these questions is vital to advancing the practice of undergraduate research in higher education. This work serves as a companion to previously published quantitative studies that have explored similar questions (Davis et al., 2015; Davis & Jones, 2017; Garner et al., 2018; Mahatmya et al., 2017) and contributes to the overall body of scholarship informing successful mentoring practices.

METHODS

The focus of this article is the examination of an UR program at a large state-funded research university in the United States, which serves as a case study for the development of mentoring relationships and their influence on students. We recognize a case study does not generalize to all mentoring relationships (Gomm et al., 2009; Lincoln & Guba, 2009; Sáez & Carretero, 1998), however appropriate naturalistic generalizations may be made when considering empirical data derived from “direct and vicarious experience” (Stake, 1978). To collect this type of experiential data, we deployed an online survey and conducted focus groups and interviews; all portions of this study were pre-approved by Mason’s Institutional Review Board. Participants were undergraduate students in sections of an interdisciplinary research seminar that was a component of an internal undergraduate research grant program. This UR program is a competitive university-wide program, where students are selected to participate based upon the feasibility, creativity, and faculty support of their proposed research project. Approximately 60 students participate per academic semester. To be selected into the program, students must have formed a relationship with a faculty mentor and developed and submitted a research proposal, that if funded, would be completed during the following semester. The acceptance rate for

the UR program varied from 45-55%. Once accepted, students and their faculty mentors received a stipend, which could be allocated for supplies and other research supports. Students earned 0-3 credit hours for the semester experience and there was no expectation for the projects to continue beyond the semester, although many did.

The program did not initiate student-faculty relationships. Nor did the program include specific and directed student-faculty coaching on mentee-mentor relationships. The program focused on supporting the student in the completion of their research through the professional development of an interdisciplinary cohort of undergraduate researchers. That the mentee-mentor relationship was not a component of the program became the impetus for this research study, as we began to become interested in how these relationships formed and evolved.

Students in the UR program during the 2014-2015 academic year were invited to complete an online survey at the conclusion of the interdisciplinary research seminar. This survey included both open- and closed-ended items exploring the origins of their mentoring relationship and how it changed over time. Likert scale questions assessed such characteristics as the relationship with the research mentor, the student’s personal motivation for success, and the student’s general satisfaction with collegiate life. This survey was based on an instrument previously used to assess UR at a public, primarily undergraduate serving institution. Detailed information on the instrument, the sample, and overall descriptive analysis can be found in Mahatmya et al. (2017). Students were not provided an incentive for participating and identifying information was not collected from any of the students. This sampling procedure yielded survey data from 105 students (125 invited participants, 84.0% response rate), although not all students completed all information in the survey. The students were distributed across eight colleges within the university. About 60% of students completing the survey were female. Approximately half of the sample was from the humanities and social sciences, 20% from engineering, with the remaining from physical and mathematical sciences and performing arts.

In our survey, we asked a number of open-ended questions that allowed students to describe how they came to work with their faculty mentor as well as the development of that relationship over the course of the research project. For example, one prompt was: “Describe how you came to work with your research mentor. Were you assigned to work with one another? If so, describe that assignment process. If not, who reached out to whom?” while another was: “Describe how you determined what your research mentoring relationship would be like. Did you have a formal contract? Was it an informal negotiation? How did your research mentoring relationship change throughout the semester?” We did not define “formal” or “informal” for students, allowing them to determine whether they thought their relationship included a “formal contract” or was based on “informal negotiation” however they may have defined those terms. We also asked students to describe in their own words whether and how their relationship shifted over the course of their research project and the frequency with which they met and spoke to their mentor (regardless of mode, to include the phone, in person, or via email) over the course of their research project. Students also described whether and how their communication shifted over the course of their project. An additional set of items asked students to report the frequency with which their mentor displayed 12

specific behavioral characteristics associated with strong mentors using a Likert scale (response options were frequently, sometimes, and rarely). Those behaviors included helping choose appropriate models, techniques, or methods for their work, communicating clear expectations for their work, and providing constructive feedback. Responses to the individual survey questions are summarized below.

The last question of the survey asked whether they would be willing to participate in a focus group discussion on similar topics. Those who were willing provided their contact information that was collected in a separate electronic file (to prevent identifying them with their previous survey responses). Thirteen students were subsequently interviewed in groups ($N = 11$ across four groups) or individually ($N = 2$). These students reflected the relatively diverse UR population of which they are a part, as there were seven men and six women, three students who identified as a racial or ethnic group other than white, and a wide distribution of academic disciplines ranging from humanities and social sciences to engineering. In addition, comparing these demographic characteristics with those of the survey participants described above, we note that the students who participated in the focus groups reflected the diversity of students who participated in the survey. The faculty members working with these students were disproportionately men (nine of the 13 mentors were men; we did not ask for information about the demographic characteristics of the mentors of all of the survey participants).

The interviewer had no prior contact with the focus group or interview participants. The focus groups and interviews were organized by schedule. Several options for meeting were made available to those students who were willing to participate, and the groups were formed based on schedule availability. Individual interviews were the result of only one student selecting a given time that fit their schedule (and for whom no other offered time was convenient). The first author analyzed the conversations and direct observation notes and coded them using inductive coding techniques to derive common themes. After initial coding, focused coding led to the emergence of themes connecting the mentoring relationship and student-centered outcomes.

RESULTS AND DISCUSSION

Our analysis explored the genesis, evolution, and impact of the mentoring relationships represented in one undergraduate research program. Notably, the population for this case study is not the average college student but are rather very driven and focused students who are motivated to pursue research. By studying the relationships that exist between these students and their faculty, we can more fully understand the circumstances that are necessary to support this high-impact practice. In this section, we describe the survey and focus group results and discuss the specific components of the undergraduate mentoring relationship. We report key survey findings in Table 1, organized by research question.

Table 1. Descriptive Findings for Origin and Development of Mentoring Relationships

Research Aim or Question	Characteristic	Percentage	
Origins of mentoring relationship	Met mentor in a class	69.6%	
	Was introduced by another faculty member or student	30.4%	
Structure of relationship	Frequency of meeting in person	Very frequently (once a week or more)	65.2%
		Sometimes (less than once a week but at least once a month)	27.5%
		Infrequently	7.3%
	Frequency of communication by email or phone	Very frequently (once a week or more)	88.4%
		Sometimes (less than once a week but at least once a month)	11.6%
		Infrequently	0%
	Frequency of communication over time	Increased over time	2.9%
		Decreased over time	10.5%
		Was consistent over time	60.9%
		Fluctuated depending on student needs	25.7%
	Formality of relationship	Formal contract	18.9%
		Informally organized	81.1%
Formality of relationship over time	Started formal, stayed formal	8.7%	
	Started formal, became informal	7.3%	
	Started informal, stayed informal	78.3%	
	Started informal, became formal	5.8%	

The interview protocol for these focus group and individual interviews consisted of 11 questions that were constructed to investigate students' perceptions of their relationship with their faculty mentors and the extent to which their UR experience shaped their undergraduate experience outside of the research environment. Students were asked, for example, "How would you describe your relationship with your faculty mentor?" and "How has your experience with undergraduate research influenced your post-graduation plans?" The full interview protocol is available upon request. The two interviews were 25 and 35 minutes in length. The duration of the focus groups ranged from 25 minutes to 60 minutes in length, with the average focus group lasting approximately 45 minutes.

All focus groups and interviews were audio recorded and the interviewer (the first author) also recorded direct observation

Beginning a mentoring relationship

The survey data showed that the majority of students (70%) met mentors in a class and either pursued or fell into their undergraduate research project through that interaction. However, students also found mentors through other course-related mechanisms. Said one survey participant, "I had seen him [the faculty mentor] present some of his past research during my honors first term course and was interested in finding out more. Following that, I set up a meeting to discuss possible projects I could feasibly complete with his resources and examined my options before committing to working in his lab for the fall." Interaction with faculty members may not lead directly to finding a research mentor, but students recounted stories of being approached by a possible mentor after an unsuccessful interaction. One student said that she "spoke

with one faculty member, and it didn't work out. Two weeks later, another faculty member approached me about working on a project as they had heard about my research interests."

While a few (19%) students had formal contracts with faculty mentors, the nature of the research projects did not merit the need for most to have a formal contract. Students with formal contracts also frequently reported in their open-ended responses that their projects were grade-bearing (although we do not know whether those without contracts were less likely to be engaged in grade-bearing research projects). Those with contracts also reported via their open-ended responses having more frequent contact with their faculty mentor and having a clearer understanding of what their mentor expected of them. Among survey participants, students without regular contact with their mentor, or an unclear understanding of what was expected of them, were more likely *not* to have had a formal mentor-mentee contract.

Evolution of the mentoring relationship during a project

Student contact with their mentor ranged from very infrequently (less than once every 3 months, 7%), to very frequently (once a week or more; 65%) with most students (88%) meeting at least every other week with their mentor. There was also variation in student communication and contact over the course of the project. While some student-mentor pairs had consistent communication across the course of the project (61%), we found that for some pairs' communication increased over time (3%), decreased over time (10%), and fluctuated depending on student needs (26%). Ten students noted that their communication may have stayed constant over the course of the relationship, but their meetings/conversations became more efficient. Said one survey participant, "Our communication changed throughout the semester because we knew what to expect of one another and felt more comfortable, so we were able to be more efficient with our work on the project."

For the majority of students (86%), there was no shift in the structure of the relationship with their mentor during the course of the project. Students whose relationship was defined by a contract or some other formal mechanism tended to maintain that formal relationship throughout the research project (9% of students). Similarly, students whose relationship was informally structured tended to maintain that informal relationship (78% of students). Among the 13% of students who noted that their relationship with their faculty mentor shifted over time, approximately half became more formal and half became less formal throughout the project. One participant in the survey noted "We had formal contact at first, but then really switched it to an informal relationship. We still get work done, but we would both rather be laughing during all of it."

Students were asked how they would define an ideal mentor both in the survey and in the focus groups/interviews. The characteristics used to describe ideal faculty mentors were knowledgeable, patient, willing to challenge, committed to students, and communicative. The students readily used the language of "mentor" to describe their own research mentor based on the application of these personal characteristics. They expected mentors to be experts in their fields but interested in patiently working with students to support the students' nascent excitement for creating knowledge in the field. Being communicative was a key characteristic that students used to define their mentors. All

students commented directly about their own mentor's openness to communicate, whether it be establishing direct lines of communication through regular meetings, the rapidity of email responses, or comfort level with providing constructive feedback and receiving queries from students. Students recounted stories of being "guided, not told, what to do in the field", of faculty members "patiently explaining how to do things", "being willing to respond to me on my level," and "giving me feedback but letting me run with my idea." Said one student,

A good mentor makes it your project, not an extension of his/hers. While the mentor can use their experience to set the direction and goals of the project, he/she needs to make sure the student understands the concepts, performs the experiment/tasks/project as the primary investigator. For example, with my mentor a lot of meeting time is spent with me explaining what I had done in the past days and going step by step through my work. He hadn't done any of the work, but he provides advice, direction when my work makes a mistake, etc.

As the above quotes reflect, being communicative meant demonstrating interest and commitment to students. The students studied felt their faculty members were committed because they gave up their time to be mentors. Indeed, the focus group participants argued that by virtue of working with undergraduates these faculty members demonstrated their commitment to students in ways that other faculty members did not. This commitment, in turn, led to students' being committed to their research, a key factor for why participation in UR leads students to be successful in future research endeavors.

To summarize, the participants highlighted the value of open and consistent communication in the development and continuation of their mentor-mentee relationship. As the relationship changed over time, the communication patterns may have changed over time. Open communication about the process meant that the student and their mentor could construct a clear working plan for the student's research project. For some students this was a formal contract, but for others it was simply an articulation of the needs of the project itself and how the student would go about completing necessary tasks. Finally, students came to label their faculty mentors as patient, supportive, and committed to them and their projects, which meant students were more committed to their projects.

Exploring connections to student outcomes

As described above, the analysis of this case study revealed several pathways through which the mentor-mentee relationships coalesced: student follow-up from a class, faculty-originated, and student-originated (outside of classroom experience). We also learned how some mentoring relationships changed over the course of the project and the importance of effective communication. Our focus group analysis indicates a connection between the origin and characteristics of the mentor-mentee relationship and the development of the undergraduate student as a researcher. A productive mentoring relationship led students to develop an identity as a competent researcher and a deeper understanding of the faculty role more broadly. This perceived competency led to three notable outcomes: changed expectations of self in the professional realm, a deeper sense of belonging, and changed expectations for post-graduation.

Consistent with previous research (Craney et al., 2011; Hunter et al., 2007; Lopatto, 2010; Wilson et al., 2012), the stronger the mentor-mentee relationship is perceived by the student, the more likely the student was to articulate her/his understanding of the nature of research in their discipline. For example, one student said, "Having such personal interactions with my mentor really added to my research experience and taught me more than just what I was learning through my research." Another noted, "because my mentor treated me like I could make a contribution, I feel like I can make a contribution to scientific knowledge, even if it is a small one." As a result of this perceived commitment by their faculty mentor, students talked about taking ownership of their projects, in part because they began to care about how their work reflected not only on them but also on their mentor. "Knowing their name would be on the project made me work harder," said one student. The others in that focus group nodded. "Yes," another student responded. "I had to do well because I cared about how this would reflect on him." This sense of interconnectedness, of working as a team, was a theme that emerged in all interviews. "Being treated as an equal was mind-blowing," said one student. "It became a partnership, and sometimes I knew more than him, so I could share knowledge." Participation in UR produced feelings of being part of something bigger than themselves. Students noted that participation in undergraduate research, and specifically through the development of an intense relationship with their mentors, they felt like they belonged. Said one focus group participant,

The university attempts to create an image and general feeling aimed at their students staying on campus that "When you are at [the university], then you are home" [quotation marks reflect air quotes used by participant. It was my student-mentor relationship that started that "when you are at [the university], then you are home" feeling. My mentor and the others that work in the lab that I work in, have become in a way extended family to me. Although it is vague it is the best way I could come up with to explain my work and relationship with my fellow researchers.

The experience of working with their mentors developed students' feelings of research competence as independent scholars. In working on a project with a mentor, they learned to balance individual contributions to a project while also working collectively to complete a task. The investment by the mentor instilled a sense of belonging in the students, who then desired to ensure that their work reflected well on them and the others in their group. Said one creative writing student, "I have attended two writing workshops my mentor runs for her graduate students because of my work with her and I felt like I belonged there."

This case study revealed a connection between the mentored UR experience and a deeper sense of belonging, a significant student development. The students also came to view themselves differently in relation to their peers and other faculty members; after being involved in a research project with a mentor, they saw themselves as part of the research community on campus, rather than just students. Some noted that they shifted their peer group to be comprised more of similar research-oriented students. Four students specifically noted that their undergraduate research experience led to a "change among friends" because they "became more cognizant of having different goals." Said another, "It was nice to find a peer group." In classes, they reported feeling more confident and less intimidated. They reported having a changed

sense of what could be accomplished through coursework; said one student, "I talk about abstract concepts faster than before and want to talk about how to go beyond the readings in my classes." Another said that now they are the student asking, "how would that apply" to new situations. Across the board they reported a new level of respect for faculty and their time. They said that they learned how to treat faculty members as they had a greater respect for the time they spent on "all their roles as faculty members." Said one, "I don't go in and waste their time anymore. I know how busy they are, and the fact that they take the time to work with me, I'm not going to take up their time just talking about nothing." These students also became more independent in their non-research coursework, likely due to increased confidence and perceived competence. In essence, the undergraduate research experience connected students with a strong advocate for the research experience, who led students to think differently about themselves through that experience, building bonding (interactions that cement groups of similar people together) and bridging (interactions that enable students to connect with heterogeneous others to bridge social divides) social capital (Chandra et al., 1998; Coleman, 1988; Garner et al., 2018).

In addition, participants expressed a sense of belonging evoked through the inclusion in research projects with faculty members that extended beyond the academic sphere. For almost all of our focus group participants, faculty mentors became more than just research mentors; they became life coaches, pseudo-parents, and sometimes friends. This result complements previously published work noting the significance of a mentor's emotional and psychological support (Glenn et al., 2012; Jacobi, 1991). For example, students routinely described their relationship with their mentor and others being mentored with the phrase "like a family". While almost all students described the importance of their relationships with their mentors outside of their academic lives, the students who invoked the language of "family" to describe these relationships were always male students. For example, one male student said, "He (the mentor) makes me feel like I have another family," to which another male student responded, "Yes, that's it! It's like an extended family!" The first student replied, "Yeah, it's like in the lab, that we are like a family, and he is like our father, and we all work together with him there." This particular exchange occurred in one focus group with four men, all doing research in lab-based sciences. This use of language, invoking family, but especially labeling mentors as fathers, was most likely to occur when the focus group (or interview) participants were all men.

While the students may have felt their female mentors fostered a sense of belonging by cultivating a pseudo-family in their research relationships, the language of "like a mother" was not invoked by any of the five students working with female mentors. Scholarship has demonstrated that undergraduate students expect women as professors to be in caring and maternal roles and are quick to point out when women do not fulfill that expectation (Sprague & Massoni, 2005). The students may indeed have experienced a sense of family with their mentors who were women, but because it was expected, they did not feel the need to comment on it. Conversely, and consistent with the literature (Sprague & Massoni, 2005), because students do not expect that kind of caring relationship with male faculty, they may have been more likely to comment on it.

Given the scholarship on men's relationships with one another and the construction of masculinity among emerging

adults (Laker & Davis, 2011), it is remarkable that these young men engaged this language to describe their academic mentors. We attribute this observation in part to a selection effect of the male mentors whose students were participating in the focus group interviews, that is, the men who chose to mentor undergraduates may themselves have been different than other male faculty members. Students thought these male mentors were committed to the next generation of scholars in their field, in a manner similar to that of coaches. Indeed, these findings of the close, personal relationships that invoke language of family among young men are consistent with scholarship that has examined the coach-athlete relationship among young men (Philippe & Seiler, 2006).

One final theme that emerged from the focus group interviews was the influence of the UR experience, including the relationships with their faculty mentors, had on the participants' post-graduation plans. All participants expressed some influence of their UR experience on their post-graduation plans. Many cited the mentoring relationship as the primary change agent. One student specifically articulated the role that his relationship with his mentor played in shaping a decision to apply to graduate school: "My mentor, my research, really helped me understand what doing professional research was like. This experience helped solidify my post-graduation plans. I am definitely applying to graduate school, and I know I will be prepared." In response to the direct question about post-graduation plans another student responded,

There is no effect on my post-graduation plans. I planned to go to graduate school and I am going to graduate school. Well, I mean, I guess I did think differently about the schools I wanted to attend, because I have to go somewhere that I can continue doing the kind of research I've been doing.

Another student explained how the mentor-mentee relationship shaped future coursework as well as post-graduation plans.

My mentor specialized in macroeconomics which is what I plan to pursue in graduate school. Accordingly, my research mentor has given me advice on not only my research, but also on different aspects of pursuing a Ph.D. in economics. Also, my mentor invited me to take his Ph.D. level math in economics course next semester. He believes based on my work this semester that I would be a good addition to the course. So, our relationship has grown beyond the constraints of this semester and this project and I think that has strengthened our mentor-mentee relationship.

A humanities student noted that,

Over the course of the project, my mentor has provided increasing advice on general research procedures, professional research, networking, aid in negotiating archives, and career and postgraduate studies. As such, the mentoring relationship has moved beyond guiding me through my project alone to more of a career mentor.

Beyond these acknowledgements of how the UR experience and their mentors facilitated stronger professional commitments and desires for post-graduate education, which has been previously described (Hunter et al., 2007; Laursen, 2010; Lopatto, 2010; Seymour et al., 2004; Wilson et al., 2012), the students reflected on how their relationship with their mentor shaped their thinking about how to be a professional adult. Faculty members provided insight into how to live a scholarly and research-oriented life, and

students took note of that example. Said one, "My mentor is a great role model for how to balance work and life, how to be a good researcher, a good parent, a good husband." These findings are consistent with previous scholarship on mentorship as a mechanism of transmitting prosocial behaviors that apply in educational, family, and other social settings (Allen, 2003). While faculty members may intend to model life as a researcher, their strong mentoring relationships with these undergraduates contribute to the overall development of their student mentees; their actions help shape how the students think about themselves and the kinds of person they aspire to be, both professionally and personally.

CONCLUSIONS

Mentoring undergraduates in the research process is time-intensive. Not all faculty members, regardless of institution type, have interest, support, or encouragement for engaging in this type of teaching (Davis & Jacobsen, 2014; Jones & Davis, 2014). However, it is clear from previous research that undergraduate students who work with a mentor are more successful in and out of the classroom than their peers who do not engage in research (Crowe, M., 2008; Fehheimer et al., 2011; Gregerman et al., 1998; Ishiyama, 2002; Kremer & Bringle, 1990; Lopatto, 2004, 2010). Our case study of a selective group of undergraduate researchers has documented not only how the UR mentoring relationship develops as a relationship, but also how it influences the development of the student as a researcher. The mentoring relationship is a key mechanism for student personal and professional development. This connection offers insight into why students who participate in undergraduate research are more successful than those who do not. Undergraduate research opportunities provide students with hands-on research experience that increases their own perceived competence, but it can be performed with a mentor who instills confidence and a sense of belonging. The mentor provides an example of a successful career path. Thus, a key contribution of our research to the discussion of the benefits of undergraduate research is the exploration of how mentoring relationships develop and subsequently influence undergraduates as researchers. A summary of the process is provided below. We observed successful mentoring relationships at a Carnegie designated R1 Doctoral University characterized by the highest research activity when students had access to research-active faculty members outside of the classroom, not simply through faculty members teaching a research hands-on class. In our case, students needed to interact with faculty members in the classroom in order to directly hear about faculty scholarly activities or to be able to tell friends about research opportunities with faculty members. Faculty and students also needed to be able to meet in non-formal ways (i.e., in hallway conversations) in order to develop social ties upon which to build formal working arrangements.

Once established, successful mentoring relationships had three main characteristics. First, faculty members engaged in practices that made transparent the research process in their discipline, using open and consistent communication. This open communication about the process of doing research as an independent scholar who was also collaborating with others directly facilitated the articulation of a clear working plan for the student's research project, the second characteristic of these successful mentoring relationships. This working plan included a communications plan with timelines, benchmarks, and expectations for the sharing of findings with others, though did not necessarily take the form of

a contract. And third, faculty members' behavior led students to perceive faculty to be patient, supportive, and committed to them and their projects.

Faculty patience, support, and commitment led students to perceive that their faculty mentors were treating them as peers. Because they believed their faculty members trusted them and that they could complete their independent scholarly work, the students developed more confidence and perceived competence. Students also gained bonding and bridging social capital, which led them to situate themselves differently in their social and working relationships with peers and other faculty members. Students also felt a sense of belonging that propelled them to want to be even more successful.

Our study is a case study of one institution and the students involved in this project were surrounded by faculty and graduate students engaged in scholarly inquiry. The students applied to participate in a selective research program for undergraduates. Therefore, one limitation to our findings is that they may only be relevant to those kinds of students at a particular type of university. Furthermore, we admit our own subjective feelings toward undergraduate research may have influenced the design of this case study (Merriam, 1998). Considering the natural experience of these students, our findings regarding the genesis, evolution, and impact of mentor-mentee relationships are informative and likely transferrable to similar relationships at other institutions. We present insight into key pathways where students exert their agency as novice scholars, through the identification of their research mentors as well as the negotiation of the mentoring relationship. We have also identified how the mentor-mentee relationship specifically improves student outcomes through the cultivation of a sense of belonging. These findings can be beneficial to other institutions regardless of their Carnegie classification.

We conclude by offering suggestions for institutions that seek ways to increase mentored undergraduate research as an educational experience. A crucial component of the undergraduate research experience is having faculty members who are willing and able to be mentors. This tends to be a more difficult task at high research activity institutions than at primarily undergraduate institutions (see Jones & Davis, 2014 for a comparison). Students and faculty need to be in an institutional environment and culture that supports the development of successful relationships. One key pathway through which students find undergraduate research opportunities and research mentors is through their classes. To facilitate this, research-active faculty could be encouraged to have a regular presence in introductory level courses. This suggestion is consistent with research of faculty mentors who report they want to work primarily with students they have seen in a classroom setting before (Davis & Jacobsen, 2014; Jones & Davis, 2014; Morrison et al., 2018) 2014; Jones & Davis, 2014; Morrison et al., 2018. In addition, it would be beneficial to have a specific set of mechanisms in place to encourage and reward faculty who mentor undergraduates, such as including mentoring as part of faculty annual evaluations as well as tenure and promotion criteria. Just as most institutions regularly recognize and reward excellence in classroom instruction, faculty members who excel at mentoring should be publicly recognized and honored for their work. Increasing the intuitional support and reward structure for faculty who mentor undergraduate researchers will, in turn, increase the number of students participating and the valuable student development outcomes we described here.

In this case study, we observed that the deep relationships formed between mentors and students led to greater confidence and perceived competency as a researcher. These relationships also led to changed expectations of self in the professional sphere, a deeper sense of belonging, and changed expectations for post-graduation. Future research that follows mentor-mentee pairs from inception to the completion of the student project (and beyond) in a systematic way would provide additional insight into how the mentoring relationship shapes students' identification as researchers, including the extent to which mentoring affects students differently across program of study.

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