# Faculty Motivation to Mentor Students Through Undergraduate Research Programs: A Study of Enabling and Constraining Factors

**Danielle X. Morales**[1] · **Sara E. Grineski**[1] · **Timothy W. Collins**[1]

**Abstract** Undergraduate research experiences are a "high impact" educational practice that confer benefits to students. However, little attention has been paid to understanding faculty motivation to mentor undergraduate students through research training programs, even as the number of programs has grown, requiring increasing numbers of faculty mentors. To address this, we introduce a conceptual model for understanding faculty motivation to mentor and test it by using empirical data to identify factors that enable and constrain faculty engagement in an undergraduate research program. Using cross-sectional survey data collected in 2013, we employed generalized linear modeling to analyze data from 536 faculty across 13 research institutions to examine how expected costs/benefits, dispositional factors, situational factors, previous experience, and demographic factors predicted faculty motivation to mentor. Results show that faculty who placed greater value on the opportunity to increase diversity in the academy through mentorship of underrepresented minorities were more likely to be interested in serving as mentors. Faculty who agreed more strongly that mentoring undergraduate students was time consuming and their institution's reward structures were at odds with mentoring, or who had more constrained access to undergraduate students were less likely to be interested in serving as mentors. Mid-career faculty were more likely than late-career faculty to be interested in serving as mentors. Findings have implications for improving undergraduate research experiences, since the success of training programs hinges on engaging highly motivated faculty members as mentors.

**Keywords** Undergraduate research experiences · Faculty motivation to mentor · Undergraduate research programs

✉ Danielle X. Morales
  xdeng2@utep.edu

[1] Department of Sociology & Anthropology, University of Texas at El Paso, 500 W. University Ave., El Paso, TX, USA

## Introduction

Undergraduate research experiences (URE) constitute a "high impact" educational practice (Kuh 2008) and a valued co-curricular activity involving increasing numbers of students and faculty members (Webber et al. 2013). A large body of empirical research in higher education has documented myriad benefits of undergraduate student participation in faculty-mentored research. For student participants, these include improved analytic and critical thinking, increased academic achievement and retention, persistence to degree completion in their chosen field, improved ability to think and work like a scientist, clarification of career plans, and improved preparedness or desire for graduate study (Bauer and Bennett 2003, 2008; Cole and Espinoza 2008; Espinosa 2009; Hathaway et al. 2002; Hunter et al. 2007; Ishiyama 2002; Kardash 2000; Kuh et al. 2007; Laursen et al. 2010; Lopatto 2004; Nagda et al. 1998; Pike 2006; Russell 2008; Seymour et al. 2004; Tompkins 1998; Volkwein and Carbone 1994; Wasserman 2000). The retention and success of underrepresented minority students in particular has been shown to be strongly related to faculty-mentored URE (Brown, Davis, and McClendon 1999; Campbell and Campbell 1997; Cronan-Hillix et al. 1986; Eagan et al. 2013; Hurte 2002; Jones et al. 2010; Luna and Cullen 1995; Schultz et al. 2011; Stromei 2000; Villarejo et al. 2008).

Although there is a growing body of research on benefits of participation in URE for students, there is less research available examining faculty participation in URE. Among studies on general faculty motivation to mentor undergraduates and faculty involvement in URE over the past five years, two articles published in *Research in Higher Education* lay the foundation for our work on this topic (Eagan et al. 2011; Webber et al. 2013). Using national data from the Higher Education Research Institute's 2007–2008 Faculty Survey, Eagan and colleagues (2011) analyzed data from 4832 science, technology, engineering, and mathematics faculty across 194 institutions. They found that faculty who worked in the life sciences and those who received government funding for their research were more likely to involve undergraduates in research projects. Faculty at historically Black colleges were significantly more likely to involve undergraduate students in research than their colleagues at predominantly White institutions and Hispanic-serving institutions (Eagan et al. 2011). Webber and her colleagues (2013) examined approximately 40,000 responses to the Faculty Survey of Student Engagement at over 450 four-year institutions. Their findings revealed that both individual and institutional characteristics predicted faculty participation in URE. At the individual level, they found African American faculty and faculty with doctorate degrees were more likely to participate in URE than their colleagues. Younger faculty, male faculty, faculty with larger course loads, and faculty with more teaching experience were slightly more likely to participate in URE than their colleagues. At institutional level, their results show "neither Carnegie category, institution type (private or public), nor size had much influence on faculty participation" in URE (Webber et al. p. 237).

While important, both studies have limitations in terms of providing a general understanding of faculty motivation to mentor undergraduates in the context of undergraduate research programs. First of all, the two studies linked faculty mentorship to important organizational citizenship behavior and social exchange theories but did not develop a broader conceptual framework to examine factors underlying faculty members' motivation to mentor undergraduate students. Further, neither study explicitly examined faculty motivation to mentor in the context of formal undergraduate research programs. Instead, they focused on the more general questions: "have you engaged undergraduates on your

research project?" (Eagan et al. 2011. p.158) and "how much time do you spend working with undergraduates on research?" (Webber et al. p. 232). In fact, many campuses in their studies did not have undergraduate research programs serving large proportions of undergraduate students. Therefore, many faculty respondents in those surveys offered research training to students on an ad hoc basis (Eagan et al. 2011; Webber et al. 2013).

The lack of attention in the literature to faculty motivation to mentor through structured research training programs is surprising given that there has been tremendous expansion of URE at many colleges and universities (Blanton 2008). According to the Council for Undergraduate Research, more than 650 colleges and universities across the US offer URE. The present culture of URE in the US is thought to have originated in 1969 at the Massachusetts Institute of Technology (MIT), where administrators declared that undergraduate students should be given the advantages of mentor–protégé relationships, allowing student protégés to be recognized as an important part of the scholarly community (Merkel 2001). MIT was followed by other research universities, the National Science Foundation (NSF), and professional and private scientific organizations, such as the Council on Undergraduate Research, that have worked together to build the current profile of URE nationwide. The US National Institutes of Health (NIH) has also established myriad programs to stimulate undergraduates' interest in biomedical research since the 1970s, such as the Minority Access to Research Careers (MARC), MARC Undergraduate Student Training in Academic Research, and Research Initiative for Scientific Enhancement programs. Today, the NSF, NIH, and US Department of Education continue to be the major funding sources for program-based URE.

This paper extends current knowledge of URE by focusing on undergraduate research programs from the prospective faculty mentor perspective. We focus on structured undergraduate research programs for four reasons. First, faculty mentors who participate in a structured research program usually receive incentives and benefits (e.g., stipends, research supplies, and/or conference travel money), which is not the case among the more commonly studied faculty who voluntarily mentor undergrads and offer research training on an ad hoc basis (Eagan et al. 2011; Webber et al. 2013). We believe those incentives and benefits may influence faculty motivation or willingness to mentor undergraduates in a way that has not yet been assessed. Second, the tremendous expansion of URE programs at many colleges and universities has meant that it is increasingly important to recruit and retain additional faculty mentors, who are tantamount to program success. Therefore, a comprehensive analysis to examine factors that influence faculty members' decisions to involve undergraduates in research in the context of structured programs is needed. Third, understanding which specific factors are tied to faculty willingness to mentor undergraduates in the context of structured undergraduate research programs will be useful to university administrators needing to prioritize the use of limited funds when institutionalizing URE after the external funds have expired. Finally, structured undergraduate research programs provide an organizing framework to the research experience, which may influence the roles and responsibilities of the faculty mentors.

Our analysis examines enabling and constraining factors shaping faculty members' motivation to mentor undergraduates through a structured training program based on results from a survey of faculty members conducted across thirteen research universities, which form part of the University of Texas at El Paso's (UTEP) NIH-funded BUILDing SCHOLARS network (http://buildingscholars.utep.edu). The UTEP-led BUILDing SCHOLARS network was funded in 2014 when the NIH invested $31 million in 10 primary institutions across the US through the Building Undergraduate Infrastructure Leading to Diversity (BUILD) program. As one of 10 primary institutions, UTEP is

addressing the needs of students in the US Southwest through a multi-institution network which includes Texas, New Mexico and Arizona, states which are home to dense concentrations of Hispanic and Native American students. The network includes seven pipeline partner institutions and twelve research partner institutions, all committed to the goal of training students from the US Southwest region to enter the NIH-funded workforce. BUILDing SCHOLARS emphasizes continuous research experiences and academic enrichment for undergraduate students, which start for many before they begin their first college course, in order to promote persistence. Starting the summer after their freshman year, students participate in a 10 week summer research program at an institution within the network. Upon graduating, BUILD students who began as freshmen or sophomores will have gained over 2000 h of research experience outside of their research-intensive coursework.

## Literature Review

Most empirical research examining mentoring relationships has focused on mentoring support from mentees' perspectives (Campbell 1997; Levinson 1978; Kim and Sax 2009; Kram 1985). However, during the past two decades, understanding the motivation or willingness to mentor others—from the mentor's perspective—has captured the attention of researchers. It is important to understand mentorship dynamics from this perspective because mentors play a key role in transmitting knowledge and experience (Kram and Hall 1996), and high-quality, committed mentors are crucial to the success of formal mentoring programs (Allen 2007; Allen and Poteet 1999; Allen et al. 2006; Ragins et al. 2000). Because mentors are the ones who ultimately choose how much and what type of mentoring to offer protégés, it is critical to examine factors influencing their behavior and decision-making (Allen 2007).

The same argument can be applied to the specific case of undergraduate research mentors. It is important to examine URE from faculty mentors' perspectives because faculty directly influence students' learning outcomes, their decisions to attend graduate school, and their career choices (Zydney 2002). In fact, success in URE initiatives can be directly linked to the ability of these programs to retain faculty mentors (Zydney 2002). Obstacles to becoming a mentor exist at both institutional and individual levels (Johnson 2002; Merkel 2001; Prince et al. 2007). Johnson (2002) argued that at the institutional level, many colleges and universities implement "university accounting systems that reward faculty exclusively for funded research and publications, typically at the cost of teaching and mentoring" (Johnson 2002, p. 90). At the individual level, some faculty hesitate to become involved in undergraduate research because it is time consuming. Undergraduate students are more likely to make mistakes than experienced graduate students, and undergraduate students need more training, explanation, and supervision than graduate students (Chopin 2002). Individual-level studies also indicate that faculty members are willing to mentor undergraduate students because they believe their students receive significant educational benefits from the research experience (Gates et al. 1999; Kardash 2000; Zydney et al. 2002). As explained by Chopin (2002, p. 3), the "tangible, measurable rewards to the professor are overshadowed by the personal satisfaction we gain by playing an active role in personal and professional growth of students."

Although some researchers have explored faculty motivation to mentor undergraduate students, few have undertaken a comprehensive analysis to examine factors that influence

faculty members' decisions to involve undergraduates in research through structured undergraduate research training programs. To our knowledge, no conceptual model has been formulated to comprehensively evaluate factors underlying faculty motivation to mentor students via URE. This paper aims to fill this gap by introducing a conceptual model for faculty mentoring motivation and by testing the model using empirical data to identify factors that enable and constrain faculty engagement in a formal undergraduate research program.

## Conceptual Framework

The motivation to mentor others is a complex, multifaceted construct, linked to individual characteristics and institutional conditions. Extending from the mentoring literature regarding the corporate world, we adapt Allen's (2007) model to a higher education context focused on faculty motivations to mentor undergraduate students through formal research training programs. Allen (2007) posits five important influences on the motivation to mentor, which include expected costs and benefits, dispositional factors, situational factors, previous mentoring experience, and demographic factors. Within these five areas, we engaged the extant literature to develop a conceptual model of hypothesized influences on faculty motivation to mentor in an undergraduate research context. Figure 1 depicts the proposed conceptual model. Hypothesized relationships between factors and the motivation to mentor are depicted with + (positive influence on motivation) and—(negative influence on motivation) signs.

### Expected Costs and Benefits

Costs and benefits are included in the conceptual model because they have been shown to be important in general mentoring studies utilizing social exchange theory (Gibb 1999; Hegstad 1999; Eagan et al. 2011; Webber et al. 2013). Social exchange theory suggests that individuals choose to engage in relationships that they expect to offer beneficial personal outcomes (Emerson 1981; Lawler and Thye 1999). In other words, when entering
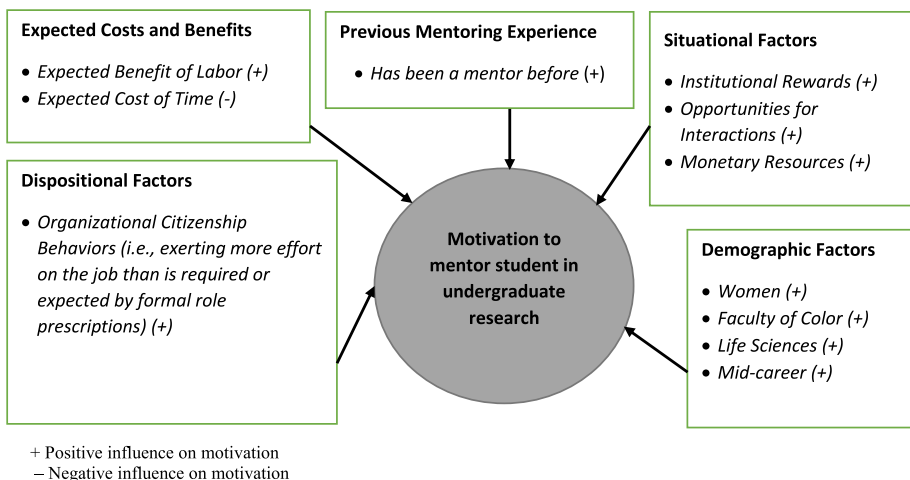


+ Positive influence on motivation
− Negative influence on motivation

Fig. 1 Conceptual model, + Positive influence on motivation, − Negative influence on motivation

into a relationship, individuals weigh the perceived costs and benefits of such a connection, as the parties involved exchange something of value (Emerson 1981). For example, among a sample of business executives, the motivation to mentor was positively related to expected benefits and negatively related to expected costs (Ragins and Scandura 1999). In the case of faculty motivation to mentor, mentoring undergraduates takes substantial time ("cost") from the already busy faculty member, while undergraduate research participants offer faculty members their labor ("benefit"), albeit in a limited form (Eagan et al. 2011). Therefore, the conceptual model supports the hypotheses that faculty motivation to mentor undergraduate students in a formal undergraduate research program is positively related to expected benefits of added help on research projects and negatively related to expected time demands.

## Dispositional Factors

Dispositional factors are attitudinal attributes that influence actions of a person. In our conceptual model of faculty motivation to mentor undergradautes, we focus on dispositional factors reflected in organizational citizenship behavior, which is particularly important in the context of mentoring (Allen 2003). McManus and Russell (1997, p. 148) define organizational citizenship behavior as "exerting more effort on the job than is required or expected by formal role prescriptions" and believe such a framework is appropriate for studies of faculty members' motivation to work with students. They argue that the link between organizational citizenship behavior and a faculty member's motivation to mentor a student becomes even more apparent when considering that, in many cases, faculty provide "assistance to protégés without that behavior being mandated or compensated by the organization" (McManus and Russell 1997, p. 149). Through this lens, we hypothesize that faculty members who engage in organizational citizenship behavior will exhibit greater motivation to mentor undergraduate students in a formal undergraduate research program.

## Situational Factors

Besides expected costs/benefits and dispositional factors, motivation to mentor others can also be influenced by situational or contextual factors. Important situational factors include institutional reward systems, opportunities for interactions, and monetary resources (Aryee et al. 1996, 1997; Einarson and Clarkberg 2004; Eagan et al. 2011). In the academic context, tenure and promotion policies are important reward systems that likely influence faculty members' motivation to mentor students in undergraduate research. Therefore, the conceptual model suggests that faculty at colleges or universities where tenure/promotion policies reward faculty for mentoring undergraduates are more likely to involve undergraduate students in research. In terms of opportunities for interactions, some faculty members have reduced access to undergraduate students to work with due to the specifics of their position (e.g., their department does not offer an undergraduate major) or because they cannot find academically prepared undergraduate students to work with. Others have the opposite problem and do not have the ability to accommodate additional undergraduate students on their research teams. Thus, we hypothesize that faculty members who have access to undergraduate students, are able to find academically prepared undergraduates to work with, and have the ability to accommodate additional students on their research teams will exhibit greater motivation to mentor students in a formal undergraduate research program. In terms of resources, research funding is most relevant in the academic context.

Eagan and his colleagues (2011) found that faculty who received government funding for their research were more likely to involve undergraduates in their research projects than faculty who did not. Hence, we hypothesize that having extramural funding positively predicts faculty members' motivation to mentor students in a formal undergraduate research program.

### Previous Mentoring Experience

The most consistent finding in the literature regarding motivation to mentor others concerns previous mentoring experience. Previous experience as a mentor and previous experience as a mentee both positively relate to motivation to mentor others (Allen 2003; Allen et al. 1997a, b; Bozionelos 2004; Ragins & Cotton 1993; Ragins & Scandura 1999). Therefore, our conceptual model posits that faculty members who have previous mentoring experience will exhibit greater motivation to mentor undergraduate students than those who do not.

### Demographic Factors

Lastly, prior research has suggested there may be differences in faculty mentorship by demographic characteristics (Antonio 2002; Bellas and Toutkoushian 1999; Eagan et al. 2011; Webber et al. 2013). For example, Webber and her colleagues (2013) found that faculty of color (particularly African American faculty) were more likely to mentor undergraduates in research than their colleagues. Another study showed that female faculty make a stronger effort to provide mentorship to students than do male faculty (Aagaard and Hauer 2003). Thus, we hypothesize that women and faculty of color will be more motivated to mentor students in a formal undergraduate research program.

Discipline and tenure status are also likely to influence a faculty member's motivation to mentor. Eagan et al. (2011, p. 166) showed that "faculty in disciplines other than life sciences had significantly lower likelihoods of involving undergraduates in research than did those in life sciences." Additionally, career stage models suggest that motivation to mentor others is strongest at mid-career (Dalton et al. 1977; Levinson 1978). Thus, we hypothesize that life sciences faculty (compared to faculty from other disciplines) and mid-career faculty (compared to early career faculty or late career faculty) will exhibit greater motivation to mentor undergraduate students through a formal undergraduate research program.

## Data and Methods

Based on the conceptual framework, this study addresses the question: to what extent do expected benefits and costs, dispositional factors, situational factors, previous mentoring experience, and demographic factors predict faculty members' motivation to mentor undergraduate students through a formal undergraduate research program?

### Data Source

Data for this study come from a cross-sectional Institutional Review Board-approved structured survey. We designed the survey to collect information on potential

undergraduate research mentors, building on a mentoring survey that was administered at Kent State University. The survey was conducted as part of a planning grant to inform the full BUILD proposal submitted to the NIH. The survey was administered using Qualtrics Survey Software to faculty with health/biomedical research experience at the University of Texas at El Paso, Arizona State University, Baylor College of Medicine, Clemson University, Rice University, University of Arizona, University of Connecticut Institute for Clinical and Translational Science, University of New Mexico Main Campus, University of New Mexico Health Sciences Center, University of Texas-Austin, University of Texas-Arlington, University of Texas-Southwestern, and University of Texas-Houston Health Sciences Center—School of Public Health. These institutions are part of the now established BUILDing SCHOLARS network, housed at UTEP (the primary institution), and they were surveyed as part of the planning process to create the network. We pilot tested the survey with a group of faculty at UTEP and then revised it before administering it.

To create our sampling frame, we asked our primary contact at each institution, who was a senior faculty member or faculty administrator, for a list of faculty members at their institution who conducted health/biomedical research broadly defined. This resulted in 887 potential respondents. The survey was administered using established web survey protocols to maximize response rate and reduce non-response bias (Cook et al. 2000; Dillman 2007; Manfreda and Vehovar 2008), which included the following steps. The 887 faculty members received a pre-notification e-mail 2 days prior to the launch of the survey in order to raise their awareness about the forthcoming study invitation. 2 days after the pre-notification e-mail was sent, potential faculty participants received a personalized e-mail invitation outlining the survey purpose, length and contents, IRB information, and details about an incentive. For non-respondents, follow-up e-mails, requesting participation, were sent weekly for three straight weeks. For those who completed the survey in its entirety, a $10 gift card link was made accessible via a follow-up e-mail. The survey was conducted in two rounds; the first round was open from mid-November through mid-December 2013 and included six institutions, and the second round, which included another eight institutions was open from mid-January to mid-February 2014. The response rate across all institutions was 60 % (with range of 42–100 %); a total of 536 individuals completed the survey.

## Variables

The dependent variable for this study is a dichotomous measure constructed from a question that asked: "Would you be interested in mentoring an undergraduate BUILD scholar from your institution?" Faculty could respond "yes" or "no." At the beginning of the survey, we described the BUILD program as the Southwest Consortium of Health Oriented education Leaders and Research Scholars (SCHOLARS), led by the University of Texas at El Paso. In the survey, an undergraduate BUILD scholar was described as an undergraduate student research assistant, likely from an underrepresented group, on a scholarship. The survey also noted that there would likely be incentives for participation by faculty mentors. Table 1 provides the coding scheme for the dependent variable as well as for all independent variables used in the analyses, and Table 2 provides descriptive statistics for each variable. Approximately 86 % of faculty in the sample reported being interested in mentoring an undergraduate BUILD scholar from their institution. We grouped our independent variables into the five factors outlined in our conceptual framework. To operationalize the five factors, we employed measures developed from single survey items, not composite scales.

**Table 1** Description of variables and measures

| Variables | Scale range |
|---|---|
| Dependent variable | |
| Would you be interested in mentoring an undergraduate BUILD (research program) scholar from your institution? | 0 = No, 1 = Yes |
| Expected costs and benefits | |
| Supervising undergraduate research is time-consuming | 1 = Strongly disagree — 4 = Strongly agree |
| I receive help from undergraduates on my research | 1 = Strongly disagree — 4 = Strongly agree |
| Dispositional factors | |
| I value the opportunity to increase diversity in the academy through mentorship of underrepresented minority undergraduates | 1 = Strongly disagree — 4 = Strongly agree |
| I enjoy teaching students about research | 1 = Strongly disagree — 4 = Strongly agree |
| I am able to help students be better prepared for graduate studies | 1 = Strongly disagree — 4 = Strongly agree |
| Situational factors | |
| Funding ("Never been a PI on a NIH or NSF grant" is the reference group) | |
| PI on a NIH grant only | 0 = No, 1 = Yes |
| PI on a NSF grant only | 0 = No, 1 = Yes |
| PI on both a NIH grant and a NSF grant | 0 = No, 1 = Yes |
| Research by undergraduates does not help me with my annual review, tenure, and/or promotion | 1 = Strongly disagree — 4 = Strongly agree |
| I don't have access to undergraduate students to work with | 1 = Strongly disagree — 4 = Strongly agree |
| I don't have the ability to accommodate additional students on my team | 1 = Strongly disagree — 4 = Strongly agree |
| It is difficult to find undergraduate students who are academically prepared for my research | 1 = Strongly disagree — 4 = Strongly agree |
| Previous mentoring experience | |
| Have you ever done any undergraduate student research mentoring? | 0 = No, 1 = Yes |
| Demographic factors | |
| Sex: female | 0 = Male, 1 = Female |
| Race/ethnicity (White is reference group) | |
| Asian | 0 = No, 1 = Yes |
| Hispanic | 0 = No, 1 = Yes |
| Other race/ethnicity | 0 = No, 1 = Yes |
| Discipline (Life sciences is the reference group) | |
| Social science | 0 = No, 1 = Yes |
| Engineering | 0 = No, 1 = Yes |
| Clinical/medical sciences | 0 = No, 1 = Yes |
| Early career professor | <7 years as a faculty member |
| Mid-career professor | 7–20 years as a faculty member |
| Later career professor | >= 20 years as a faculty member |

**Table 2** Descriptive statistics ($n = 536$)

| Variables | Frequency | Missing (%) | Mean | SD[a] |
|---|---|---|---|---|
| **Dependent variable** | | | | |
| Would you be interested in mentoring an undergraduate BUILD (research program) scholar from your institution? | | | | |
| No | 72 | 6.3 | 0.14 | |
| Yes | 430 | | 0.86 | |
| **Categorical independent variables** | | | | |
| Sex | | | | |
| Male | 267 | 14.2 | 0.58 | |
| Female | 193 | | 0.42 | |
| Race/ethnicity | | | | |
| White | 370 | 0.0 | 0.69 | |
| Hispanic | 93 | | 0.17 | |
| Asian | 57 | | 0.11 | |
| Other | 16 | | 0.03 | |
| Discipline | | | | |
| Life science | 166 | 0.0 | 0.31 | |
| Social science | 67 | | 0.12 | |
| Engineering | 43 | | 0.08 | |
| Clinical/medical sciences | 260 | | 0.49 | |
| Career stage | | | | |
| Early career | 174 | 0.0 | 0.32 | |
| Mid-career | 191 | | 0.36 | |
| Late career | 171 | | 0.32 | |
| Previous mentoring experience | | | | |
| No | 36 | 4.7 | 0.07 | |
| Yes | 475 | | 0.93 | |
| Funding | | | | |
| Neither NIH nor NSF | 168 | 0.0 | 0.31 | |
| Only NIH | 274 | | 0.51 | |
| Only NSF | 31 | | 0.06 | |
| Both NIH and NSF | 63 | | 0.12 | |
| **Continuous independent variables** | | | | |
| I value the opportunity to increase diversity in the academy through mentorship of underrepresented minority undergraduates | | 16.2 | 3.55 | 0.59 |
| I enjoy teaching students about research | | 14.6 | 3.61 | 0.53 |
| I am able to help students be better prepared for graduate studies | | 14.2 | 3.62 | 0.50 |
| Research by undergraduates does not help me with my annual review, tenure, and/or promotion | | 15.3 | 2.47 | 0.83 |
| I don't have access to undergraduate students to work with | | 11.0 | 1.99 | 0.79 |
| I don't have the ability to accommodate additional students on my team | | 11.6 | 2.34 | 0.75 |
| It is difficult to find undergraduate students who are academically prepared for my research | | 9.3 | 2.53 | 0.84 |

**Table 2** continued

| Variables | Frequency | Missing (%) | Mean | SD[a] |
|---|---|---|---|---|
| Supervising undergraduate research is time-consuming | | 8.6 | 3.24 | 0.68 |
| I receive help from undergraduates on my research | | 15.3 | 3.00 | 0.74 |

*Expected Costs and Benefits*

To operationalize the costs and benefits of mentoring undergraduates in research, we used survey items prefaced with the statement: "Please rate the extent to which the following items are barriers that you face in including undergraduate students in your research projects." For the variable "help on research," we used responses to the item: "I receive help from undergraduates on my research." To construct the variable "time", we used responses to the item: "Supervising undergraduate research is time-consuming." Both variables were rated on 4-point Likert scales (1 = strong disagree strongly—4 = strongly agree). The "help" variable represents a critical benefit that hypothetically comes with mentoring students on research, while the "time" variable is more closely linked to the costs of mentoring undergraduate students on research.

*Dispositional Factors*

Three variables were constructed to operationalize dispositional factors using responses to the survey prompt: "Please rate the extent to which the following items are benefits that you receive from working with undergraduate students on research projects." We used responses to the following three items when constructing the three variables: (i) "I value the opportunity to increase diversity in the academy through mentorship of underrepresented minority undergraduates." (ii) "I enjoy teaching students about research." (iii) "I am able to help students be better prepared for graduate studies." The three items were rated on 4-point Likert scales (1 = strong disagree strongly—4 = strongly agree), and the analysis variables were untransformed. These three items map to the concept of organizational citizenship in the context of faculty mentoring via URE because they indicate faculty commitments beyond prescribed expectations and duties. In most institutions, faculty are not specifically expected to mentor underrepresented minority undergraduates and guide undergraduate students in research, even though they may be expected to do so with graduate students. In order to perform these tasks, most faculty mentors must devote extra time and effort beyond their regular working hours.

*Situational Factors*

Five variables were constructed to measure the three situational factors in our conceptual model. Institutional rewards was measured by the variable (i) "tenure and/or promotion system." Opportunities for interactions was measured by (ii) "access to undergraduates," (iii) "lack of academically prepared undergraduates," and (iv) "lack of ability to accommodate undergraduates." Monetary resources was measured by (v) "funding." We used responses to survey items prefaced with the statement: "Please rate the extent to which the following items are barriers that you face in including undergraduate students in your research projects" to construct the first four variables. We used responses to the following four items: (i) "Research by undergraduates does not help me with my annual review, tenure,

and/or promotion." (ii) "I do not have access to undergraduate students to work with." (iii) "I do not have the ability to accommodate additional students on my team." (iv) "It is difficult to find undergraduate students who are academically prepared for my research." Responses were rated on 4-point Likert scales (1 = strong disagree—4 = strongly agree).

In addition, the (v) "funding" variable was constructed using yes/no responses to two questions: "Have you ever been a PI on a NIH grant?"; and "Have you ever been a PI on a NSF grant?" Responses to these were recoded into a variable with four categories (each coded 0 = No or 1 = Yes): (a) had never been a PI on a NIH grant or a NSF grant; (b) had been a PI on a NIH grant; (c) had been a PI on a NSF grant; (d) had been a PI on both a NIH grant and a NSF grant. The reference group included those who had never been a PI on a NIH or NSF grant. The survey specified R, K, T, F, and P Series awards from the NIH and asked about any research grant from NSF; thus, this variable encompasses both research and training awards. These items represent situational factors because they are related to the faculty members' job context, including the presence (or absence) of an institutional reward structure that values their mentoring of undergraduate students, the opportunity (or lack thereof) to interact with undergraduate students, and their experiences as PIs engaging in funded research.

### Previous Mentoring Experience

We used the following survey question to construct a previous mentoring experiences variable: "Have you ever done any undergraduate student research mentoring?" Responses were coded as 0 = No or 1 = Yes.

### Demographic Factors

We constructed variables measuring four demographic characteristics: sex, race, discipline, and career stage. To construct the race variable, we used two survey questions: "What is your race?" and "Are you of Hispanic, Latino or Spanish origin?" The cell sizes for Blacks (2 % of sample), Native Americans (1 % of sample), and others (1 %) were too small to analyze separately. Thus, we recoded the data into four mutually exclusive categories (each coded 0 = No or 1 = Yes): Asian (non-Hispanic) (11 %), Hispanic (17 %), and Other (which includes Black, Native American and other; all are non-White and non-Hispanic) (3 %), using the reference group of White (non-Hispanic) (69 %).

We also analyze two variables that measure additional faculty characteristics. While not asked directly in the survey, we were able to cross-reference faculty members' disciplines using an Internet search. We categorized all respondents into four broad disciplinary groups (each coded 0 = No or 1 = Yes): life sciences (reference group), social sciences, engineering, and clinical and medical sciences. We measured career stage using responses to question: "How many years of experience do you have in higher education as a faculty member?" Responses were recoded into three categories: early career faculty (0–7 years); mid-career faculty (7–20 years); and late career faculty (more than 20 years). In total, there were 174 early career faculty, 191 mid-career faculty, and 171 late career faculty in the sample. Mid-career faculty was used as the reference group.

### Missing Data

Table 2 shows that the percent missing for the variables ranged from 0 to 16 %. To reduce non-response bias, the missing values of all analysis variables were multiply imputed.

Multiple imputation (MI) involves creating multiple sets of values for missing observations using a regression-based approach and is currently considered a best practice for addressing missing data in statistical analysis. MI is used to avoid the bias that can occur when missing values are not missing completely at random and is appropriate for self-reported survey data (Enders 2010). Using IBM SPSS version 22 statistical software, 20 imputed data sets were specified to increase power and 200 between-imputation iterations were used to ensure that the resulting imputations were independent of each other (Enders 2010). The use of 20 data sets is recommended in MI as it maximizes power and improves the validity of multi-parameter significance tests (Enders 2010). We analyzed all independent variables based on ordinal measures (derived from survey responses to Likert-type scales) as continuous predictors. This approach is considered a best practice in MI when imputing missing data and estimating model parameters, since rounding off imputed values based on discrete categorical specifications has been shown to produce more biased parameter estimates in analysis models (Allison 2005; Enders 2010; Horton et al. 2003; Rodwell et al. 2014). Before analyzing the data, we excluded cases with a relatively high proportion of missing data (i.e., more than 50 % missing for the variables included in the analysis), which resulted in the loss of 22 cases.

## Analyses

We began our analyses using hierarchical generalized linear modeling (HGLM). HGLM is the most appropriate statistical technique to use when analyzing multi-level (clustered) data to predict a dichotomous outcome (Raudenbush and Bryk 2002). Our data have a clustered design, as faculty are nested within thirteen institutions; HGLM accounts for the inherent hierarchical nature of such data and provides robust standard errors to reduce the likelihood of Type I statistical errors (Raudenbush and Bryk 2002). Furthermore, because this method appropriately partitions variance in the outcome between individuals (faculty) and groups (institutions), it allows for the estimation of the unique effects of institutional context on faculty members' interest in involving undergraduate students in research projects.

In building models within HGLM, the analyst must first ensure that the outcome significantly varies across institutions. To do this, we analyzed the random variance component from a fully unconditional model, which is a model without any predictors, to determine whether faculty members' average probability of being interested in mentoring undergraduate students significantly differed across the thirteen universities. Surprisingly, the fully unconditional model suggested that the institutions under study did not differ significantly in the average proportion of faculty who were interested in mentoring a student.

The results from the fully unconditional model of HGLM indicated that we did not need to conduct a multilevel model since the outcome did not significantly vary across the fourteen institutions. Therefore, we proceeded with building a generalized linear model (GzLM) to examine relationships between the independent variables and the dependent variable at only the faculty-level. In contrast to linear regression models, which assume normally distributed dependent variables, GzLM support analysis of non-normal distributions and for multiple link functions (Nelder & Wedderburn 1972). Given that the dependent variable is a dichotomous variable, we selected the binomial distribution in the GzLM. To select the best fitting GzLM, we compared model fit when using different link functions appropriate for binomial distributions and for our dependent variable, i.e., logit link, complementary log–log link, and probit link, using the Akaike Information Criterion

(AIC) (Garson 2012). We report results from the GzLM using a binomial distribution with logit link as the final model, because it had the lowest AIC. IBM SPSS version 22 was used to conduct all analyses. We tested for possible multicollinearity among the analysis variables. According to variance inflation factor, tolerance, and condition index criteria (Belsley et al. 1980), inferences from GzLM results were not affected by multicollinearity problems.

## Results

We present the results of the GzLM in Table 3. With regard to expected costs and benefits, faculty who agreed more strongly that mentoring undergraduate students was time consuming were significantly ($p = 0.033$) less likely to be interested in mentoring through this program. In terms of directionality, faculty who agreed more strongly that they could receive help from undergraduates on their research were more likely ($p = 0.055$) to be interested in mentoring.

Considering variables related to dispositional factors (e.g., organizational citizenship behavior), faculty who placed greater value on the opportunity to increase diversity in the academy through mentorship of underrepresented minorities were significantly ($p = 0.047$) more likely to be interested in mentoring undergraduate students through this undergraduate research program. Faculty who agreed more strongly that they enjoyed teaching students about research and who believed more strongly that URE helps students prepare for graduate school were not significantly more likely to be interested in mentoring a student through this undergraduate research program.

Results for situational factors were mixed. In terms of institutional rewards, faculty members who agreed more strongly that mentoring undergraduates would not help with the annual review, tenure, and/or promotion were significantly ($p = 0.039$) less likely to be interested in mentoring students through this undergraduate research program. In terms of opportunities for interactions, faculty who had more constrained access to undergraduate students to work with were significantly ($p = 0.005$) less likely to be interested in mentoring undergraduate students. In terms of directionality, faculty who agreed more strongly that it was difficult to find undergraduate students who were academically prepared for research were more likely ($p = 0.060$) to be interested in mentoring through this undergraduate research program. The lack of ability to accommodate additional undergraduates did not approach significance.

In terms of monetary resources, the results were not statistically significant. In terms of directionality, we found that faculty who had been a PI on both a NIH grant and a NSF grant had a higher probability ($p = .054$) of being interested in mentoring students through this program compared to faculty who had never been a PI on a NIH or NSF grant and having been a PI on either a NIH or NSF grant (vs someone who was a PI on neither type of grant) increased the probability of being interested in mentoring students. Previous mentoring experience was also not a significant predictor in the model. However, the coefficient was positive and in the expected direction.

In terms of the four demographic characteristics (sex, race/ethnicity, discipline, and career stage), results indicate that late career faculty (as compared to mid-career faculty) were significantly less likely ($p = 0.013$) to be interested in mentoring students in this undergraduate research program. The difference between early career and mid-career faculty was not statistically significant. The other three demographic variables were not

Table 3 GLM using a binomial distribution with a logit link function predicting faculty's motivation to mentor undergraduate students in URG ($n = 536$)

|  | Odds ratio | Std. error | $p$ |
|---|---|---|---|
| Expected costs and benefits |  |  |  |
| I receive help from undergraduates on my research | 1.51 | 0.22 | 0.055 |
| Supervising undergraduate research is time-consuming | 0.56* | 0.27 | 0.033 |
| Dispositional factors |  |  |  |
| I value the opportunity to increase diversity in the academy through mentorship of underrepresented minority undergraduates | 2.03* | 0.36 | 0.047 |
| I enjoy teaching students about research | 1.40 | 0.38 | 0.378 |
| I am able to help students be better prepared for graduate studies | 0.83 | 0.42 | 0.657 |
| Situational factors |  |  |  |
| Funding/Grant ("Never been a PI on a NIH/NSF grant" is the reference group) |  |  |  |
| PI on a NIH grant only | 0.86 | 0.40 | 0.708 |
| PI on a NSF grant only | 0.83 | 0.77 | 0.804 |
| PI on both a NIH grant and a NSF grant | 4.12 | 0.73 | 0.054 |
| Research by undergraduates does not help me with my annual review, tenure, and/or promotion | 0.90* | 0.22 | 0.039 |
| I don't have access to undergraduate students to work with | 0.51** | 0.24 | 0.005 |
| I don't have the ability to accommodate additional students on my team | 0.73 | 0.23 | 0.180 |
| It is difficult to find undergraduate students who are academically prepared for my research | 1.59 | 0.25 | 0.060 |
| Previous mentoring experience |  |  |  |
| Have you ever done any undergraduate student research mentoring? | 2.86 | 0.74 | 0.158 |
| Demographic factors |  |  |  |
| Sex: female | 1.65 | 0.36 | 0.165 |
| Race/ethnicity (White is the reference group) |  |  |  |
| Asian | 0.48 | 0.47 | 0.117 |
| Hispanic | 1.32 | 0.47 | 0.556 |
| Other race/ethnicity | 0.59 | 0.73 | 0.478 |
| Discipline (Life science is the reference group) |  |  |  |
| Social science | 1.00 | 0.60 | 0.996 |
| Engineering | 0.55 | 0.65 | 0.356 |
| Clinical/medical sciences | 1.01 | 0.37 | 0.974 |
| Career stage (Mid-career faculty is the reference group) |  |  |  |
| Early career faculty | 1.24 | 0.39 | 0.578 |
| Late career faculty | 0.39* | 0.37 | 0.013 |

* $p < .05$; ** $p < .01$

statistically significant. In terms of directionality, female and Hispanic faculty were more likely to be interested in mentoring students through this program than were males and White (non-Hispanic) faculty members. Clinical/medical faculty were more likely, and engineering faculty less likely, than life science faculty to be interested in mentoring through this undergraduate research program.

## Discussion

Although there is a growing body of research on benefits of URE for students, few studies have comprehensively examined factors influencing faculty members' decisions to involve undergraduates in their research through a structured undergraduate research training program. Understanding factors influencing participation of faculty in formal training programs is critically important since such programs receive substantial and increasing financial investments and are a key mechanism by which students engage in URE. To address this gap in understanding, we introduced a conceptual model for faculty motivation to mentor through an undergraduate research program, which includes five factors. Variables were constructed to operationalize each of the five factors. Results of the generalized linear model (GzLM) aligned with some of the hypothesized influences on faculty motivation to mentor. In this section, we first discuss and answer the question: To what extent do expected benefits and costs, dispositional factors, situational factors, previous mentoring experience, and demographic factors predict faculty members' motivation to mentor undergraduate students through a formal undergraduate research program?

With regard to the two variables related to expected costs and benefits, we found that faculty who agreed more strongly that supervising undergraduates was time-consuming were significantly less interested in mentoring students via undergraduate research programs, and that faculty who agreed more strongly that undergraduate students could contribute to their research were more interested, although not statistically significantly so. The directionalities of these findings align with our hypotheses, which are rooted in social exchange theory. While effectively mentoring undergraduate students does tend to be time-consuming—since they typically require enhanced explanation, reassurance and supervision (Chopin 2002)—faculty members may also receive substantial benefits from the mentoring relationship through student work on research projects. However, in our model, faculty expected "benefits" was not a significant predictor of motivation.

With regard to dispositional factors, our results reveal that faculty who placed greater value on the opportunity to increase diversity in the academy through mentorship of underrepresented minorities were significantly more interested in serving as mentors, which supports the hypotheses we derived from organizational citizenship theory. Organizational citizenship theory suggests that, if individuals believe roles separate from their prescribed duties are actually integral elements of their work, they will be more likely to voluntarily fulfill those roles (Herzberg 1966; Judge et al. 2001; McManus and Russell 1997). Our results suggest that faculty who place greater value on diversity in the academy are more motivated to engage in this undergraduate research program as mentors to students from underrepresented backgrounds, even though increasing the diversity of the academy is not a formal faculty duty. This aligns with prior research suggesting that faculty members' commitments to undergraduate education may prompt their desires to improve undergraduate students' experiences, regardless of the presence of tangible incentives to do so (McManus and Russell 1997; Organ and Ryan 1995). The other two variables related to organizational citizenship behavior did not approach statistical significance in the model, suggesting that teaching students about research and helping them prepare for graduate school are less important in motivating faculty to serve as mentors to students in undergraduate research programs, which may contradict commonly held assumptions about why faculty participate in undergraduate research experiences.

In terms of situational factors, we hypothesized that faculty (i) within institutional contexts where tenure/promotion policies reward mentoring undergraduates, (ii) with opportunities for interactions with undergraduate students, or (iii) with extramural funding would be more motivated to serve as research mentors. Some findings support these three hypotheses. As expected (i), faculty members who agreed more strongly that their institution's reward structures and incentive structures were at odds with mentoring were significantly less interested in mentoring undergraduates through this formal undergraduate research program. This parallels O'Meara and Braskamp's (2005) finding that faculty face institutional obstacles in mentoring undergraduate students because current promotion and tenure systems typically emphasize research productivity over engagement with undergraduate students. Eagan and colleagues (2011, p.172) also argued that "if institutions provide incentives for faculty engagement with undergraduate students, they may increase faculty members' likelihoods of involving undergraduates in research." Further, faculty members who had more constrained access to undergraduate students to work with were significantly less interested in serving as undergraduate research mentors. This result supported our hypothesis (ii). It is plausible that faculty members who have little contact with undergraduate students typically lack functional roles in their research programs to easily accommodate training opportunities, and therefore are substantially less interested in serving as mentors to undergraduates. Counter to expectations, having the ability to accommodate another student was not a significant predictor of motivation to mentor, suggesting that the number of undergraduate mentees that any given faculty member may be able to manage is somewhat flexible. In terms of hypothesis (iii), faculty members with funding had a greater interest in mentoring students through this program, although the results were not statistically significant at the $p < 05$ level.

Among the four variables representing demographic factors, career stage was the only significant predictor in our model. Results show that late career faculty were significantly less interested in serving as undergraduate research mentors than were mid-career faculty members, which supported our hypothesis derived from career stage models of mentoring (Dalton et al. 1977; Levinson 1978). According to Dalton and his colleagues (1977), people at both mid-career and late career stages have similar abilities to influence, guide, and direct other people because of their broadened interests and increased capabilities. However, compared to those at mid-career, people at the late career stage tend to have more responsibilities in their organizations; therefore, they usually do not have enough time or energy to mentor others. For example, Allen et al. (1997b) found that late career supervisors reported fewer intentions to mentor others than mid-career supervisors. These findings are relevant to undergraduate research mentoring. While both mid-career faculty and late career faculty have hypothetically similar abilities to mentor, the amount of energy that late career faculty can devote to mentoring undergraduate students may be on the decline because late career faculty are more likely to have administrative responsibilities at their universities and in their professional communities than mid-career faculty. When studying mentoring via URE, analysts have tended to treat faculty professional or career-related characteristics (e.g., rank, tenure status) as control variables without providing more detailed discussion or explanation regarding the implications of results (e.g., Eagan et al. 2011; Einarson and Clarkberg 2004; Webber et al. 2013). Our results underscore that the relationship between career stage and motivation to mentor via URE is important to focus on (rather than simply control for), especially in terms of the practical implications for engaging faculty as mentors in structured programs, whether they are externally funded or institutionally supported.

## Limitations

Several limitations are acknowledged in this study. First, data reported herein were captured from self-reported surveys given at one point in time. Although inaccurate self-reports could affect the size or strength of statistical findings, it is appropriate to use in studies like ours where the main focus is on understanding the relationships among variables and not finding point estimates (Pike 1995, 1999). Second, due to limitations with the questions included in our survey, we used various unidimensional indicators to measure our concepts instead of multidimensional scales. Third, we studied mentoring motivation in this paper but did not link it to mentoring behavior. In fact, mentoring intention and willingness to mentor others is more commonly studied (e.g., Allen 2003; Allen et al. 1997b; Aryee et al. 1996; Ragins & Cotton, 1993) than is mentoring behavior (Johnson 2002; Merkel 2001; Prince et al. 2007). Future longitudinal research should seek to link faculty willingness to mentor undergraduates with their future mentoring behaviors. Fourth, we asked about previous mentoring experience in the survey, but did not ask about faculty respondents' satisfaction with their previous mentoring experience. Research demonstrates that mentors who were highly satisfied with their current and prior mentoring relationships with protégés also reported greater willingness to serve as mentors in the future (Eby et al. 2005, 2006; Wang et al. 2009). Fifth, when constructing the three measures of dispositional factors, we assumed that faculty members were not formally expected, as part of their job requirements, to mentor underrepresented minority undergraduates, teach research to undergraduate students outside of the classroom, and/or prepare students for graduate studies. However, these duties may represent formal job requirements for faculty members in some institutional contexts or might otherwise be viewed by some faculty as prescribed job responsibilities. We lack the requisite data to determine whether these three tasks are (or are perceived by faculty to be) "official" vs. "extra" duties, which reflects a limitation in terms of how we operationalized dispositional factors. Sixth, among faculty members indicating interest to participate as research mentors, it is unknown if they planned for themselves or others from their research groups, such as graduate students or post-docs, to serve as primary mentors. Finally, our sample includes faculty members with health/biomedical research experience from thirteen institutions, and findings may therefore not be generalizable across other academic fields and institutions.

## Implications and Conclusion

Undergraduate research experiences have become a national focus in higher education. Participation in structured undergraduate research programs offers broad benefits to students and some advantages for faculty mentors. Given the influence that faculty mentors have on training program and student success, program directors and higher-level administrators at institutions that value undergraduate education should proactively strive to increase faculty members' motivation to serve as mentors. Here, we clarify the practical implications of our study findings in reference to our conceptual model and provide six recommendations with regard to faculty recruitment targeted toward undergraduate research programs and program directors, and college administrators who are seeking to institutionalize undergraduate research programs that are currently externally funded. Table 4 demonstrates how the BUILDing SCHOLARS program is implementing recommendations as an example of how some may be actualized.

**Table 4** How building scholars is implementing the practical implications

Provide research skills training to undergraduate students (recommendation #1)

  Offering a summer college readiness boot camp for entering freshmen trainees

  Offering an interdisciplinary research foundations course to all trainees

  Providing authentic course-based undergraduate research experiences for trainees

  Developing a peer mentoring program that trains peer research education leaders

Encourage extracurricular faculty-undergraduate student interactions (recommendation #2)

  Offering an annual symposium involving the trainees and faculty from UTEP and all research and pipeline partner institutions

  Organizing occasional social activities (e.g. holiday reception and summer cookout)

Promote faculty awareness of the positive impacts of mentoring underrepresented minority students (recommendation #5)

  Organizing high profile campus events with nationally known mentoring speakers

Incentivize faculty participation in undergraduate research programs (recommendation #6)

  Instituting annual college-wide mentoring awards at UTEP with cash prizes

  Working to make research mentoring recognizable as research productivity as faculty go up for tenure and promotion at UTEP

## Incentivize Faculty Participation by Providing Research Skills Training to Undergraduate Students Before They Engage in Faculty-Mentored Research

We found that faculty motivation to mentor undergraduate students in research is influenced by the expected benefit of assistance on projects. Therefore, undergraduate research program directors may incentivize faculty participation by providing research skills training to undergraduate students before they engage in faculty-mentored research, since highly-prepared students can better assist with less remedial guidance. If programs provide training for students, mentoring undergraduates will become less time-consuming and will be more likely to support, rather than hinder, faculty members' research productivity. Research skills training can be implemented in a variety of ways including program boot camps where students learn basic research skills, or entering research (mentee) trainings (Branchaw et al. 2010). Programs directors can also adopt cohort models or peer-mentoring models for their programs, where students can receive training from more senior students in faculty mentors' research teams (Knox et al. 2006; Lopatto 2010; Prince et al. 2007) and benefit from a more dynamic, collaborative, and supportive learning environment.

## Provide More Opportunities for Extracurricular Faculty-Undergraduate Student Interactions

Our study shows faculty who believed more strongly that they did not have access to undergraduate students to work with were significantly less likely to be interested in mentoring undergraduate students in this program. Related to this, we agree with the observation made in previous studies that having more contact with undergraduates outside of coursework may improve faculty members' perceptions of working with undergraduates on research (Harvey and Thompson 2009; Prince et al. 2007). Thus, we suggest that undergraduate research program directors seek to provide more opportunities for extracurricular faculty-undergraduate student interactions. Those interactions will increase

faculty motivations to mentor students; in turn, having positive working relationships with undergraduate students is likely to improve faculty members' job satisfaction and general morale (Johnsrud and Rosser 2002; Rosser 2004). Potential venues for extracurricular interaction include regular luncheons that include faculty and undergraduate students; research colloquia and workshops appropriate for all levels of faculty and students; and program social networking webpages engaged by faculty and students.

## Utilize Targeted Recruitment Strategies to More Effectively Attract Faculty Mentors at Different Career Stages

Our findings suggest that mid-career faculty members were more motivated to serve as mentors than senior faculty. It stands to reason that most undergraduate research programs will thrive largely due to the engagement of mid-career faculty as mentors. It is important to recognize, however, that senior faculty members tend to have rich research experiences, extensive academic networks (often comprised of influential senior faculty), and the drive to solidify their scholarly legacies. Working with research-active senior faculty may provide valuable opportunities for undergraduate students, although many programs may not fully tap that potential. Therefore, program directors and university higher administrators should devise and implement more effective strategies to recruit senior faculty. For example, this could be done by engaging them through targeted campaigns focused on what they can offer students as mentors (e.g., deep research/disciplinary knowledge, access to scholarly networks), and, in turn, what participation in URE can offer them (e.g., an opportunity to mold the next generation of scholars in their field). Such campaigns should incorporate opportunities for senior faculty to interact face-to-face with students who are currently engaged in in URE.

## First Target Faculty Members with Extensive Experience as PIs of Externally-Funded Research Projects, but Also Engage Non-funded Mentors by Providing More Programmatic Resources

Eagan et al. (2011) found that faculty whose research was externally funded were more likely to involve undergraduates in their research; similarly, this study suggests that faculty who had been a PI on a NIH and NSF grant may be more motivated to serve as mentors. Therefore, mentor recruitment efforts should first target faculty members with extensive experience as PIs of externally-funded research projects, since they will likely be highly motivated to participate. Program directors and higher administrators may also more effectively elicit participation and transform perceptions across all faculty members via information campaigns highlighting that fact that the most successful research faculty are also highly motivated to engage as mentors through URE. On the other hand, programs operating at universities without many grant-funded faculty and those interested in placing students with early career professors who are less likely to have PI experience may need to offer more incentives to recruit faculty mentors. When faculty are interested but do not have enough resources of their own, programmatic resources can offer particularly powerful incentives.

## Promote Faculty Awareness of the Positive Impacts of Mentored Research Training on Underrepresented Minority Students

Our findings indicate that faculty who placed greater value on the opportunity to increase diversity in the academy through mentorship of underrepresented minorities were more motivated to serve as mentors. This means that undergraduate research program directors and higher administrators may want to promote faculty awareness of the positive impacts of URE on underrepresented minority students (e.g., in terms of retention, persistence) in their efforts to recruit faculty mentors for programs. For example, information campaigns highlighting the documented benefits of UREs for underrepresented minority students could serve to better align engagement in URE mentoring with faculty values, and provide a low-cost approach to motivate increased participation.

## Incentivize Faculty Participation in Undergraduate Research Programs by Altering Reward Structures

Our findings also reveal that faculty motivation to mentor undergraduate students in research is influenced by the institutional reward system. Therefore, we suggest that program directors work with higher administrators to transform institutional reward systems to include mentorship as a more highly valued criterion in tenure, promotion and annual review policies; to develop formal accounting mechanisms for crediting mentorship occurring outside of coursework to faculty workloads; and to create mentoring awards programs with cash prizes. While many universities have acknowledged the existence of conflicting institutional incentives, which create barriers to faculty engagement in undergraduate research mentoring, some are creatively seeking to reward faculty who mentor students. Purdue University provides one example. In July 2015, they shifted priorities in tenure reviews. Besides the traditional focus on faculty accomplishments in research, teaching, and service, they have included the expectation that faculty serve as active mentors to undergraduates, especially those deemed "at-risk" (Jaschik 2015). As Purdue's Provost Deba Dutta stated: "Research universities need to be producing new scholars to promote new scholarship, and to stop separating the student experience from the promotion of research excellence. The student experience must be central…" (Jaschik 2015, p.1). Further, we agree with the suggestion provided by Eagan and colleagues (2011)—college administrators can actually institutionalize the structured undergraduate research programs that are currently funded by organizations like NSF and NIH by developing incentive strategies to sustain URE long after the external funding has expired.

To conclude, there has been tremendous expansion of undergraduate research programs in the US. As the number of programs continues to grow, program directors and university administrators will increasingly face faculty mentor recruitment challenges. In spite of this looming challenge, there has been very limited research conducted on faculty motivation to mentor undergraduate students, and no previous studies have explored faculty motivation to mentor in the context of structured UREs. This paper is a first step toward building a research agenda focused on faculty mentors in structured UREs with the ultimate goal of motivating more faculty members to take part in this important enterprise.

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