Student and Faculty Member Engagement in Undergraduate Research

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Abstract

Undergraduate research is a valued co-curricular activity that has involved increasing numbers of students and faculty in recent years. While there is a growing body of research on student participation in UR, there is less research available examining faculty perceptions of, participation in UR, and how those factors influence student participation in UR. This study examined approximately 110,000 responses to the *National Survey of Student Engagement* (NSSE) and 40,000 responses to the *Faculty Survey of Student Engagement* (FSSE) at over 450 four-year institutions. Findings revealed that individual and institutional characteristics predicted student and faculty member involvement, and that the majority of faculty members perceived UR to be of importance. Implications for fostering faculty involvement and promoting the importance of undergraduate research are discussed.

Introduction

During the past 15 years, undergraduate research has gained increasing prominence as a feature of the American college experience, in large part due to the Carnegie Commission report that urged reform in undergraduate education to make "research-based learning the standard" (Boyer Commission Reports, 1998). Because of the calls to better integrate students in research, there has been tremendous expansion of programs at many colleges and universities, and some propose that undergraduate research has moved from 'cottage industry' to a 'movement' (Blanton, 2008).

Participation in undergraduate research (UR) has positive benefits for student success as well as advantages for faculty and graduate students who serve as mentors to undergraduate

students. For students themselves, participation in UR has been found to positively affect analytic and critical thinking (Bauer & Bennett, 2008; Kardash, 2000; Kuh, Chen, & Nelson Laird 2007 Pike, 2006; Volkwein & Carbone, 1994), increase academic achievement and retention (Cole & Espinoza, 2008; Ishiyama, 2002; Nagda, Gregerman, Jonides, von Hippel, & Laursen, 1998), clarify choice of academic major (Tompkins, 1998; Wasserman, 2000; Seymour, Hunter, Laursen, & Deantoni, 2004), and promote enrollment in graduate school (Bauer & Bennett, 2003; Hathaway, Nagda, & Gregerman, 2002; Seymour et al 2004; Lopatto, 2004; Russell, 2008).

Faculty members who work with undergraduates on research have to invest extra time and effort, but they, too, benefit from the experience. Zydney, Bennett, Shaid, and Bauer (2002a) and Adedokun, Dyehouse, Bessenbacher, and Burgess (2010) found that faculty mentors report significant benefits to their quality of work and life. Potential future faculty—graduate students—benefit as well. Dolan and Johnson (2009) found numerous benefits for graduate students who serve as mentors to UR students, including greater career preparation, improved teaching and communication skills, and cognitive growth.

While there is a growing body of research on student participation in UR and the benefits of UR for those involved, there is less research available examining faculty perceptions of and participation in UR and how those factors influence student participation in UR. Two studies provide a useful start for the latter work (Eagen, Sharkness, Hurtado, Mosqueda, & Chang, 2011; Kuh, Chen, & Nelson Laird, 2007), but have important limitations in terms of providing a general understanding of faculty participation in UG. The study by Eagen et al. was limited to science, technology, engineering, and mathematics (STEM) faculty and did not examine faculty perceptions, nor did it link faculty measures to student participation. Kuh, Kinzie, Buckley,

Bridges, & Hayek. (2007) did look at faculty perceptions and participation in UG and did positively link those factors to student participation in UG, but they did not report full model results. Also, both studies were limited to a fairly small institutional sample (about 200 institutions). The goal of the current study is to build off of previous work that offers insight into faculty perceptions of and participation in UR as well as to examine the link between those faculty measures and student participation in UR. This study also extends previous examination of student and faculty engagement in UR via multilevel modeling that enables us to more precisely examine the contribution of institutional characteristics while holding individual characteristics constant. In this study, we examine factors that influence faculty members working with undergraduates on research, factors that contribute to faculty perceptions of the importance of research, and factors that influence student participation in undergraduate research and thus offers a unique opportunity to examine both faculty and student perceptions about as well as participation in a well-recognized co-curricular activity.

Literature Review

Growth in Undergraduate Research

Since the Boyer Commission's (1998) call to integrate students in the research experience over a decade ago, there has been a great expansion of formal UR programs across many colleges and universities, transforming the practice from "a cottage industry to a movement" (Blanton, 2008). Although UR was originally considered primarily for students in research universities and had its formal beginning in 1969 at MIT, it has grown widely, and throughout all levels of baccalaureate education (Hunter, et al 2010). Over the past two decades, Hu, Kuh and Gayles (2007) found that undergraduate research programs in liberal arts and doctoral institutions have grown at a faster pace than similar programs at research universities. That

growth may be due to curriculum changes and/or student and faculty interest. Public and private support for UR confirms its importance, and supports students through targeted activities as well as through individual faculty researchers who receive extramural research funding. NSF REU awards in chemistry for 2009 averaged $10,000 per summer UR student (Colon, 2009) and one study of 136 universities reported a total investment of $68.2 million for UR activities (Hunter et al, 2010).

As UR has expanded in colleges and universities, so too has the depth and breadth of experiences that have been included in the scope of UR. The definition used to designate UR determines an institution's participation rate (Webber, Fechheimer, & Kleiber, 2012), and the depth, duration, and kind of UR activity can have a significant impact on the student and faculty gains received (Beckman & Hensel, 2009). As "an inquiry or investigation, conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline," the CUR definition for undergraduate research is quite broad, and reflects the intellectual content of the scholarly inquiry rather than the structure or format of the experience (http://www.cur.org). The decision to use a broad definition is advantageous in that it enables students to get involved in some aspect of the inquiry-based process of learning, based on the area of student preference and level of commitment.

UR and Student Skill Development

The fundamental goal for undergraduate research activities is to strengthen the skills and abilities for baccalaureate students. Through a variety of short and long-term programs, UR is shown to have multiple benefits, including student acquisition of analytic and synthetic thinking, confidence in ability to make presentations/speak publicly, and assist with employment and/or graduate school. With both academic year and summer science interns, Kardash (2000) reported

that students made significant gains in research skills, including formulation of research hypotheses, data analysis, and written communication. Nagda, et al (1998) found participation in UR to increase African American retention. Consistent with previous findings (Bauer & Bennett, 2008; Hu, Scheuch, Schwartz, Gayles, & Li, 2008; Nagda et al, 1998), Buckley, Korkmaz, and Kuh (2008) found that the nature and extent to which students engage in UR determines the extent of benefit. If students get involved in reviewing the literature, contributing to research questions, methods, data analysis, and presentation of the findings, they are more likely to report making authentic gains in thinking and skill development compared to students who engage in surface tasks. Because a considerable amount of time and effort can be spent on UR, students participating in other time-intensive activities such as athletics or Greek life may mitigate students' participation in UR. Additionally students engaged in online or distance learning may not as easily make the connections to faculty members that are necessary for UR.

In a multi-institution study, Lopatto (2004) found multiple benefits for students, including evidence of critical thinking and strong interest in postgraduate study (Lopatto, 2007). In a broad evaluation of NSF's undergraduate research programs (Russell, 2005) students reported many positive gains from UR, including increases in understanding aspects of science, confidence about research, achieving better GPAs, graduate school, and a career in science. Specifically, Russell reported that 75% of the respondents reported an increased interest in a STEM career as a result of their participation in UR.

Students' ability to become proficient at inquiry and synthetic thinking are important for deep learning and may be enhanced through UR. To that end, Kuh, Chen and Nelson Laird (2007) found that when faculty members are actively engaged in research and help students to integrate and synthesize information (deep learning), student learning outcomes are greater.

Indeed, faculty as mentors are an important component to effective UR and student learning, and Eagen, Sharkness, Hurtado, Mosqueda, & Chang (2011) remind us that faculty member workload varies by type of institution and discipline. These authors found that faculty members in the life sciences were more likely to engage students in UR than peers in other disciplines. They also found that faculty members in HBCUs and liberal arts colleges were more likely to engage students in UR than peers at predominantly white institutions and master's comprehensive institutions, respectively.

Along with gains during college, the benefits of UR appear to last for students well beyond their baccalaureate years. Alumni who participated in UR as undergraduates were more likely to attend graduate school (Bauer & Bennett, 2003; 2008; Laursen, Hunter, Seymour, Thiry, & Melton, 2010) and remain in contact with research faculty after graduation (Hathaway, Nagda, & Gregerman, 2002). Based on survey responses from nearly 1,000 alumni, some of whom has participated in undergraduate research and some of whom had not participated in research as an undergraduate, Bauer and Bennett (2003) found that participation in research was valued by alumni. When asked to rate their satisfaction and long-term value of their undergraduate experience, alumni respondents who participated in research as undergraduates rated their experience significantly higher than those alumni who did not participate in UR. It is not surprising, then, that 92% of alumni who participated in UR said the experience was 'very' or 'extremely important' to their overall education (Bauer & Bennett, 2003).

The Effect of UR on Faculty Members

While the reasons for and effects of participation in UR on students are paramount, it is also important to examine the rationale for and effects of participation in UR for faculty members. Success in promoting effective UR can be explained in large part by the presence of

faculty who engage in UR and research (Zydney et al, 2005b). Some faculty hesitate to get involved in UR because it is time consuming and may have graduate students or postdoctoral researchers who can complete tasks more quickly than undergraduate students new to the research endeavor. Because undergraduate students need more training and supervision than graduate students, involvement with UR students requires planning and preparation. However, some faculty members believe that their students receive significant educational benefits from the research experience (Gates, Teller, Bernat, Delgado & Della-Piana 1999; Kardash, 2000; Zydney, Bennett, Shahid, & Bauer, 2002b). In a survey of faculty who worked with UR students at one research university, Zydney et al. found that faculty respondents said they believed the research experience contributed substantially to cognitive and affective development of their students, including intellectual curiosity, understanding scientific findings, thinking logically about complex material, and synthesizing information from diverse sources. Similarly, Adedokun, Dyehouse, Bessenbacher, and Burgess (2010) found that faculty members believe undergraduate students contribute positively to research projects and that these interactions with students provide opportunities for collegiality and professional relationships. These findings follow the position by Chopin (2002): 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." (p.3).

When such planning can occur, the rewards for faculty members can be positive. In a university where 90% of STEM faculty participate in UR, Zydney, Bennett, Shahid, and Bauer (2002a) found that ¾ of faculty respondents who were involved in UR, did so because they had a desire to influence the career of talented young students. In addition, they found that half of the faculty respondents said UR students contributed to the faculty member's research program, and

41% said UR involvement contributed to the faculty member's quality of life at the institution. Collectively, findings from these studies indicate that many faculty members do get involved in UR and find benefit to themselves and/or their students.

Conceptual Framework

This study is guided by theoretical frameworks that examine student and faculty motivation for participation in UR. Student and faculty member involvement in UR can be viewed through the lens of motivation for success. Students may participate in UR for personal gain (e.g., course credit, financial reimbursement for work, recommendation for graduate school), whereas faculty members may be motivated to participate in UR for a wider variety of motivations. Faculty members participate due to personal satisfaction that comes from mentoring students, assistance with research tasks that can lead to a lighter personal workload, and/or perhaps because they affirm the institution's overarching goal to provide students with academic activities that assist in student success. Interactions with students in an undergraduate research activity can be a positive and rewarding experience for both faculty member and student.

Although some students may begin or continue to seek academic activities based on internal interests and self-satisfaction, Ryan and Deci (2000) purport that, in general, levels of intrinsic motivation decreases as one progresses through one's academic career, becoming less self-determined. It is, therefore likely that students may participate in UR based on extrinsic motivation. Earning good grades and/or recommendation to graduate school may serve as motivators for UR participation. A number of studies on academic motivation have relied on tenets of self-determination theory (SDT; Deci et al,1991). Based on SDT, Fortier, Vallerand, and Guay (1995) proposed a motivational model of school performance in which perceived academic competence and academic self-determination influence levels of academic motivation

which, in turn, influence school performance. From this point of view, it could be argued that students who engage in extracurricular activities such as undergraduate research do so because they realize that it will strengthen their intellectual skills and subsequent academic performance.

Student and faculty member involvement in UR may also be viewed through the related concepts of social exchange theory. With major tenets proposed by Blau (1968), Homans (1974), Thibault and Kelly (1959) and Emerson (1976), social exchange theory proposes that actions are contingent on rewarded reactions from others and that interpersonal transactions have the potential to create high-quality relationships. As a form of reciprocity, the more often a person perceives value and/or is rewarded, the more likely s/he is to perform the action. Through the lens of social exchange theory, it is possible that students become involved in undergraduate research because they believe it will help them to learn a concept or skill more thoroughly, earn better grades, or increase chances for graduate school or post-college employment.

A construct directly related to social exchange theory is perceived organizational support (POS). Eisenberger and colleagues (Cottrell, Eisenberger, & Speicher 1992; Eisenberger & Huntington, 1986) posit that organizational rewards and favorable job conditions such as pay, promotion, and job enrichment contribute more to one's perceived organizational support (POS). The benefits of POS are understood in reciprocal terms; if the employee's POS is high, he or she will be motivated to work to achieve high outcomes. Although POS has not focused on employees in the college or university environment, its tenets can be reasonably applied to examine faculty member decision to participate in the undergraduate research activity.

Faculty members may get involved in UR because they believe that, in exchange for academic credit or knowledge acquisition, students can accomplish some tasks that they would otherwise have to do. Faculty workloads are high, and student assistance may make myriad tasks

more management/provide some relief. Even in cases where faculty members do not find undergraduate student assistance appreciably helpful with their research, faculty members may participate in UR because they believe that sharing knowledge and skill acquisition with students is a valued role they should perform as a faculty mentor. In this way, faculty members may see their involvement in UR as a 'fair exchange' that enables him or her to contribute to the development of a young scholar by transferring knowledge and/or skills about scientific inquiry.

While the propositions of POS apply well to faculty members, we propose to extend the ideas related to POS to students in UR. Students may get involved in UR because they will receive reward for involvement. Reward may come in the form of stipend for lab work, academic credit, strong recommendation for graduate school, and/or the acquisition of deeper knowledge about a specific topic. In reciprocal terms, students may see their interactions with faculty members and involvement in UR as beneficial for educational and knowledge goals.

Purpose of the Study

Clearly, faculty interactions with students in UR can strengthen students' undergraduate success as well as beyond. Faculty time must be stretched across multiple tasks, and faculty research orientation and external funding have impact on participation (Hu, Kuh, & Gayles, 2007). However, faculty work roles and involvement in UR are critical to student involvement in UR. It can aid in faculty member quality of life but greater understanding of the factors that contribute to faculty involvement in UR is needed. In addition, some students proactively seek participation in UR early in baccalaureate studies, but other students may not make the initial involvement until faculty invite students to participate. Thus looking at faculty perceived importance of undergraduate research as well as faculty and student participation can help us see how faculty members help students in this activity. To date, we have few studies that have

examined student *and* faculty member reports on participation in and perceptions of benefits gained from participation in undergraduate research. Examination of responses from faculty and students at the same institutions can provide a much-needed and not yet examined understanding of the benefits of UR. Specifically, our research questions were as follows.

1. What student demographic and institutional characteristics contribute to student participation in undergraduate research?
2. What individual and institutional characteristics contribute to faculty member perceived value of participation in research with undergraduate students?
3. What demographic and institutional characteristics contribute to faculty member participation in undergraduate research?

Responses from two items from FSSE and one item from NSSE served as the focus for our analyses. The FSSE questions were: 1). *How important is it that undergraduates at your institution work on a research project with a faculty member outside of course or program requirements*, and 2). *How much time do you spend working with undergraduates on research*. The NSSE item asked students if they will have *worked on a research project with a faculty member outside of course or program requirements* by the time the graduate from their institution.

Data and Methods

Data Sources and Samples

Data for this study come from the *National Survey of Student Engagement* (NSSE) and the *Faculty Survey of Student Engagement* (FSSE) The NSSE is a survey chosen by officials at many colleges and universities to examine student participation in college activities and is based on the Seven Principles of Good Practice in Undergraduate Education (Chickering & Gamson,

1987). NSSE measures student engagement in activities that have been positively linked to important student learning outcomes (Astin, 1993; Chickering & Gamson; Love & Love, 1995; Pascarella & Terenzini, 2005). Thus, an increase in engagement in activities, such as undergraduate research, should increase student learning (Kezar, 2006).

The FSSE questionnaire was designed to complement NSSE by collecting information about faculty members' expectations and perceptions of undergraduate student engagement in educationally purposeful activities, how faculty members structure their classroom activities and spend their time, and the extent to which faculty promote student learning and development in their courses and interactions with students. There are two options of the FSSE survey, one that focuses on faculty members' responses about the typical first-year or senior that they have taught during the school year, and one that asks faculty to respond to questions based on a course taught during the current academic year. Faculty that answered either option of FSSE were included in this analysis.

Support for NSSE and FSSE's reliability and validity come from many sources, including scholarly research and work done at individual institutions. Numerous studies support NSSE's and FSSE's reliability and validity (Kuh, Hayek, Zhao, & Carini, 2002; Kuh, Nelson Laird, & Umbach; 2004; Carini, Kuh, & Ouimet, 2001; Pascarella, Seifert, & Blaich, 2010; Umbach & Warynski, 2005).

Data from five years of NSSE and FSSE administrations (2007-2011) were combined for use in this study. In order to be selected, institutions had to participate in both NSSE and FSSE, with only their most recent year of participation included. The resulting datasets included faculty and student responses from 455 institutions from across the U.S. Institutions varied across several characteristics with a little over half being privately controlled, half were master's

granting and a third baccalaureate granting, around three in ten were less competitive and three in ten were very/highly competitive, and nearly half of smaller size. After deleting cases for missing data, the sample of students consisted of 111,077 seniors, 19% of which reported having participated in research with a faculty member. Around a third of the sample was 24 years or older, most were full-time, two-thirds were female, and a third were in STEM fields. The majority of respondents were full-time students (83%) and few lived on campus, were student athletes (6%), members of a Greek organization (12%), or were international or foreign national (5%).

After deleting cases for missing data, the FSSE sample consisted of 39,699 faculty members, 57% of which reported spending at least some time researching with undergraduates. Around a third were 55 years or older, half were female, a third were in a STEM field, and faculty were fairly evenly divided among academic ranks. For more details about the institutional characteristics or student and faculty demographics see Table 1.

Variables Used in This Study

The literature on undergraduate research, student learning, and faculty member work in UR with students discussed above guided the selection of variables included in this study. Faculty and student involvement in research was measured with three items. On NSSE, students were asked whether or not they had worked on a research project with a faculty member outside of course or program requirements. On FSSE, faculty were asked how important it is to them that undergraduates at their institutions work on a research project with a faculty member outside of course or program requirements and how many hours they spend in a typical seven-day week working with undergraduates on research. In addition to being used as dependent measures, the two faculty variables were aggregated to the institution level to examine the link between

averages of faculty support for UR and faculty participation in UR in the student models of this study.

Other institution-level characteristics included in the analyses were Carnegie classification, control, selectivity, and size. Faculty-level characteristics included in the models were academic discipline, academic rank, age, citizenship, course load, highest degree earned, race/ethnicity, sex, and years of experience teaching. Student-level characteristics included in models were age, athletic membership, citizenship, enrollment status, first-generation status, fraternity or sorority membership, gender, grades, living situation, major field, online courses, race/ethnicity, and transfer status. For more information on how these variables were coded, see Appendices A-C.

Analysis

Following an examination of summary statistics, and because our data consisted of faculty and students within institutions, we used hierarchical linear modeling (HLM) and hierarchical generalized linear modeling (HGLM) to account for the multilevel, nested nature of our data (Raudenbush & Bryk, 2002). Some scholars believe the use of traditional regression techniques is inappropriate when examining data at multiple levels (Hahs-Vaughn, 2006; Thomas & Heck, 2001) because it may result in inaccurate parameter estimates. The use of hierarchical modeling overcomes this concern by simultaneously estimating equations for both the individual and institutional effects. In addition, multilevel analyses take clustered data structures into account when producing estimates for within and between-group variances and do not require testing for design effects (Thomas & Heck).

Many scholars who use multilevel models begin with a null model followed by one or more models that incorporate additional variables (Raudenbush & Bryk, 2002). The null model

includes no predictor variables, but estimates the variance that exists within and between institutions. For the student and faculty indicators of participation in UR outside of class, the null models look like the following:

Level 1

$$\log[\varphi_{ij}/(1 - \varphi_{ij})] = \beta_{0j}$$

Level 2

$$\beta_{0j} = \gamma_{00+} u_{0j}$$

where $\log[\varphi_{ij}/(1 - \varphi_{ij})]$ refers to the likelihood of participation for student or faculty member *i* at institution *j*. For the importance faculty members place on UR, the null model was the following:

Level 1

$$Y_{ij} = \beta_{0j} + r_{ij}$$

Level 2

$$\beta_{0j} = \gamma_{00+} u_{0j}$$

For all models, the significant chi-square statistic indicated a non-saturated model and the need to include more variables, thus a broader HLM model was developed to examine the effect of additional factors on UR participation and perceived importance of UR. The full model for student participation in UR with a random intercept and fixed slopes is expressed as follows:

Level 1

$$\log[\varphi_{ij}/(1 - \varphi_{ij})] = \beta_{0j} + \beta_1(\textit{Major-STEM field}_{ij}) + \beta_2(\textit{Mostly B grades}_{ij}) + \beta_3(\textit{Mostly A grades}_{ij}) + \beta_4(\textit{Athletic membership}_{ij}) + \beta_5(\textit{Fraternity/sorority membership}_{ij}) + \beta_6(\textit{Age}_{ij}) + \beta_7(\textit{US citizenship}_{ij}) + \beta_8(\textit{FT enrollment status}_{ij}) + \beta_9(\textit{First generation}_{ij}) + \beta_{10}(\textit{Asian}_{ij}) + \beta_{11}(\textit{Black}_{ij}) + \beta_{12}(\textit{Latino}_{ij}) + \beta_{13}(\textit{Other race/ethnicity}_{ij}) + \beta_{14}(\textit{Female}_{ij}) + \beta_{15}(\textit{Live on campus}_{ij}) + \beta_{16}(\textit{Transfer}_{ij}) + \beta_{17}(\textit{Online enrollment}_{ij})$$

Level 2

$\beta_0=\gamma_{00} + \gamma_{01}(Carnegie\ master's_j) + \gamma_{02}(Carnegie\ baccalaureate_j) + \gamma_{03}(Private_j) +$

$\gamma_{04}(Selectivity\ competitive_j) + \gamma_{05}(Selectivity\ very\ competitive_j) +$

$\gamma_{06}(Selectivity\ highly\ competitive_j) + \gamma_{07}(Size\ small_j) + \gamma_{08}(Size\ medium_j) + \gamma_{09}(Size\ large_j) +$

$\gamma_{10}(Size\ other_j) + \gamma_{11}(Faculty\ importance\ of\ UR_j) + \gamma_{12}(Faculty\ time\ spent\ on\ research_j) + u_{0j}$

The model for faculty members spending at least some time on UR was similar at Level 1, except the variables included were those in Appendix B. At Level 2, the equations were the same except the aggregated faculty variables were not included in the faculty model.

The full model for the importance faculty members place on UR, a variable treated as continuous in our analyses, is expressed as follows:

Level 1

$Y_{ij} = \beta_{0j} + \beta_1(Academic\ discipline\ STEM\ field_{ij}) + \beta_2(Rank\ associate\ professor_{ij}) +$

$\beta_3(Rank\ assistant\ professor_{ij}) + \beta_4(Rank\ FT\ lecturer/instructor_{ij}) + \beta_5(PT\ lecturer/instructor_{ij}) +$

$\beta_6(Age_{ij}) + \beta_7(US\ citizenship_{ij}) + \beta_8(Course\ load_{ij}) + \beta_9(Doctoral\ degree_{ij}) + \beta_{10}(Asian_{ij}) +$

$\beta_{11}(Black_{ij}) + \beta_{12}(Latino_{ij}) + \beta_{13}(Other\ race/ethnicity_{ij}) + \beta_{14}(Female_{ij}) + \beta_{15}(Years\ teaching_{ij}) +$

r_{ij}

Level 2

$\beta_0=\gamma_{00} + \gamma_{01}(Carnegie\ master's_j) + \gamma_{02}(Carnegie\ baccalaureate_j) + \gamma_{03}(Private_j) +$

$\gamma_{04}(Selectivity\ competitive_j) + \gamma_{05}(Selectivity\ very\ competitive_j) +$

$\gamma_{06}(Selectivity\ highly\ competitive_j) + \gamma_{07}(Size\ small_j) + \gamma_{08}(Size\ medium_j) + \gamma_{09}(Size\ large_j) +$

$\gamma_{10}(Size\ other_j) + u_{0j}$

All independent variables were grand mean centered before entering the analyses. Missing data were removed through listwise deletion, and there were no outliers present in the data.

Results

Participation in UR

Three hierarchical models were run to examine variables that predict student and faculty participation as well as perceived importance of UR by faculty members. Shown in Table 2, a variety of student and institution characteristics were predictive of whether students were more likely to participate in undergraduate research. Looking at personal characteristics, younger students (less than age 24), U.S. citizens, non-first-generation students, non-white students, and male students were all more likely to participate in UR than female, older, foreign, first generation, and white students, respectively. As shown in Table 2, students having certain college experiences were also more likely to participate in UR such as students in STEM fields, students in fraternities and sororities, and students with higher grades. Students that were more connected to their campus, such as students living on campus, non-transfer students, full-time students, and students not taking their courses entirely online, were also more likely to participate in UR. Institutional characteristics seemed to be generally less predictive than student characteristics, but some differences were seen. Students not at Master's classified institutions, at highly selective institutions, and at smaller institutions were more likely to participate in UR. Sensibly, students at institutions where a greater percentage of faculty spent at least some time on UR and where faculty found research to be more important and were more likely to participate in UR. To learn more about what predicts both faculty time spent and importance placed on UR, we ran our models on those faculty variables.

Table 3 shows predictors related to faculty member participation in UR. As shown, a variety of faculty characteristics, but only one institutional characteristic, predicted faculty likelihood of spending at least some time on UR. Looking at personal characteristics of faculty, younger faculty (younger than 55), non-white faculty, and male faculty were all more likely to participate in UR. Educational and working characteristics of faculty were also predictive of participation such as being full professors, faculty with larger course loads, faculty with doctoral degrees, and faculty with less than fifteen years of teaching experience. Also shown in Table 3, Carnegie category, institution type (private/public), nor size had an influence of faculty participation, however, institutional selectivity did. Results show that faculty at more selective institutions are more likely to spend at least some time on UR. Compared to the least competitive four-year institutions, the likelihood that faculty would spend time on UR went up incrementally, with the greatest likelihood occurring at highly competitive institutions.

Our third and final hierarchical analysis examined predictors related to faculty perceived importance of UR. Previously shown in Table 1, the majority of faculty said that it was important for undergraduate students to participate in UR. This finding may indicate that the institutional culture can reinforce student participation. As shown in Table 4, the results for perceived importance were similar to those for spending some time on UR (this is not a surprise since the two dependent measures were strongly related—as an indicator $r = 0.58$). For example, younger faculty (younger than age 55), U.S. citizens, non-white faculty, and male faculty placed more importance on UR. Also, full professors, faculty with doctoral degrees, and faculty with less than fifteen years of teaching experience placed more importance on participating in UR. Faculty in STEM fields found UR to be more important which must play a role in the finding that STEM students are more likely to participate in UR, since STEM faculty were not more

likely than their non-STEM colleagues to spend time on UR. Another small, but noticeable difference in findings is that although faculty with larger course loads are more likely to spend at least some time on UR, it is faculty with smaller course loads that find UR more important. Similar to findings presented in Table 3, faculty characteristics were more predictive of the importance placed on UR than institutional characteristics, with selectivity being the only significant institution-level predictor of importance placed on UR (with faculty at more selective institutions placing more importance on UR).

Discussion

Due to several prominent publications over the past two decades, undergraduate research has gained increasing prominence as a feature of the American college experience. Many scholars have studied and confirm the benefits of student participation in UR. Findings from this study reaffirm student and faculty reported interest in and perceived value from participation in UR and parallel findings for Eisenberger and Huntington's (1986) notions of perceived organizational support. In addition, results reinforce Kuh, Chen, and Nelson Laird's (2007) finding that the importance that faculty members place on UR is positively related to the proportion of students who participate in UR, even after controlling faculty time spent on UR and select institutional characteristics.

Predictors that are associated with student participation in UR are consistent with some previous studies (e.g., Russell, 2008) that find UR participation is higher for students with better grades, enrolled full-time, and from highly competitive institutions. It is noteworthy that compared to white peers, minority students in this study report higher participation in UR, as do men, those who live on campus, and those who do not enroll in online education courses. Consistent with findings by Hu, Kuh, and Gayles (2007), being in a large research university

does not necessarily equate with higher participation rates in UR by faculty members or students. Shown in Tables 3 and 4, after controlling for institution type and Carnegie classification, institution size (smaller) and selectivity (more selective) make a difference in UR participation and perceived value. These findings seem to indicate that institutional leadership may play a role in determining priorities for resource and faculty time allocations to activities like UR.

Consistent with previous findings, students in STEM majors were more likely to participate in UR. Overall, faculty participation in UR was the most important predictor in student involvement in UR. Although faculty members in STEM disciplines were not more likely to participate in UR, they did perceive it to be more important than non-STEM colleagues. This finding supports the notion that culture matters. The results for differences in faculty perceptions reinforce the notion that non-participant faculty play an important and powerful role as mentors in getting students involved in academic activities. STEM students were much more likely to participate in UR, but not because STEM faculty participated at a rate greater than non-STEM faculty. The difference between STEM and non-STEM faculty was in the importance place on UR.

Faculty of color participated at a higher rate and perceived UR of importance more so than White peers. This paralleled the finding in student participation in UR. Students and faculty members of color were more likely to participate, and faculty of color were more likely to perceive UR as an important activity. These findings suggests that institutional emphasis on bring students of color into UR may be working, but institutions may be relying (intentionally or unintentionally) disproportionately on faculty or color to get students of color involved. Though institutions have also pushed for women students to be involved in UR, our results show women still lag behind men in participation among students and faculty. Again, institution or student

subgroup culture may play a role in emphasizing student involvement. Our finding for faculty of color greater participation is inconsistent with those of Eagen, et al (2011), and calls for additional study.

Limitations

A few limitations are acknowledged in this study. First, data reported herein were captured from self-report surveys. Respondents could have indicated higher use or value of UR than what actually occurred, however, in general, self-report data is purported to be reasonably accurate (Tourangeau, Rips, & Rasinski, 2000). Secondly, there may be a bias in responses due to self-selection in UR activities. Lastly, questions to the NSSE and FSSE surveys do not allow us to gauge motivation per se nor other variables that may explain potential interest in UR. The literature on intrinsic motivation and social exchange theory aligns well in our understanding of student and faculty participation in UR, and thus intuitively fits our use of NSSE and FSSE items. If students or faculty who responded to these surveys were more motivated, generalization of our findings would be jeopardized, thus caution is warranted when interpreting the results. Future studies may wish to include a measure of motivation to control for this important construct.

Implications

Our findings support the notion that participation in undergraduate research has positive benefits for student success as well as advantages for faculty who serve as mentors to undergraduate students. Even with recent budget reductions, institution officials who wish to maximize student success should continue to invest resources in this activity. Because of the benefits found for UR participation, faculty members who are not currently involved, may wish recommend it to their students, and/or find ways to get involved at a minimal level.

Continued investment in UR seems to contribute to positive social exchange for faculty members. Our findings are consistent with previous reports of increased quality of faculty member work life from UR (Bauer & Bennett, 2008; Hu et al, 2008), and this can affect work satisfaction and faculty turnover. If faculty members perceive support from their department chair and senior administrative officials, they may be more satisfied, develop greater loyalty, and be more likely to remain at the same institution rather than seeking employment elsewhere. In addition, faculty involvement in academic advising is equally important, and those who know UR deeply, can share their knowledge with students advisees. In some cases, new undergraduates have detailed ideas on how they wish to get involved in college activities, but in many cases, students do not know and can benefit from the advice and counsel of informed faculty who know the kinds of skills needed to begin, as well as the kind of skills that can be gained from UR participation.

We agree with Pike, Smart, Kuh, and Hayek (2006) that institutional expenditures can make a difference in positive outcomes, and believe our findings reaffirm the need for institution officials to continue allocation of resources for in-class and co-curricular discovery-based learning activities. We also agree with Kuh, Kinzie, Schuh, Whitt, & Associates (2005) in that engagement requires a broad-based commitment from many people across the institution that work together to shape expectations and the campus culture. That STEM faculty perceived UR of greater importance than non-STEM peers supports the notion that culture matters and might signal that involvement with students in UR is personally rewarding for faculty mentors and can be beneficial in the completion of research tasks.

The finding that non-tenure-track faculty are less engaged seems logical since research is not part of their duties, but it is encouraging that differences in importance were less than one-

tenth of a standard deviation. Institutional officials may want to examine institution policies and reward structures so that part-time and NTT faculty can get more involved in UR. For example, faculty members may be asked to volunteer with one or more student clubs and/or interact with students over meals, at which time important conversation about faculty and student research could take place. Full-time or part-time faculty may also be rewarded for service or community-based learning that tangibly helps students see the connections between research and the world around them. Such service or community engagement also contributes to Boyer's (1990) call for a broader application of scholarship.

In addition to contributing to better understanding the roles and values of faculty members, these findings have implications for student success. There is consistent evidence that UR promotes increased critical thinking, and select skill development. If students are aware of differences based on the use of these techniques, students may wish to enroll in co-curricular programs that include UR activities. Academic activities that assist in undergraduate student success may encourage able students to consider graduate education. UR can help a student prepare for graduate school where skills such as the scientific method, synthetic and deductive thinking ability to work with others are even more important for success.

We were surprised to find female students participating in UR less than male peers. This finding may be due to the fact that proportionally more men major in STEM fields and/or see fewer female faculty members as role models. We believe that continued support via programs such as the McNair Scholar program and NSF's STEP and ASPIRE programs. Continued support for, and monitoring of female students and faculty in STEM fields is important to ensure gender equity in these disciplines in the future.

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Table 1 Selected Student, Faculty, and Institution Characteristics

Student Characteristics (For seniors only, n=111,077)	
Undergraduate Research	19% have done research with a faculty member
Age	37% 24 or older
Athletic Membership	6% student athletes
Citizenship	5% international or foreign national
Full-Time Enrolled	83% enrolled full time
First-Generation Status	47% first generation
Fraternity/Sorority	12% in a social fraternity or sorority
Female	65% female
Grades	49% mostly As, 45% mostly Bs, 6% mostly Cs
Living On Campus	17% lived on campus
Major Field	30% in a STEM field
Online Education	8% took their courses entirely online
Race/Ethnicity	5% Asian, 8% Black, 70% White, 6% Latino, 7% other
Transfer	44% transfer students
Faculty Characteristics (n=39,669)	
Undergraduate Research (Emphasis)	13% not important, 33% somewhat important, 34% important, 20% very important
Undergraduate Research (Time)	57% spent at least some time researching with undergraduates
Academic Discipline	32% in a STEM field
Academic Rank	11% part-time lecturers, 11% full-time lecturers, 26% assistant professors, 26% associate professors, 27% full professors
Age	38% 55 or older
Citizenship	6% permanent (immigrant visa) or temporary resident of the US
Course Load	Average courses taught/will teach this academic year was 5.7
Doctorate Degree	72% earned a doctoral or first professional degree
Race/Ethnicity	4% Asian, 5% Black, 77% White, 3% Latino, and 11% Other
Female	47% female
Years Teaching	48% 15 or more years teaching
Institution Characteristics (n=455 institutions)	
Carnegie Classification	17% doctoral, 45% masters, 39% baccalaureate
Private	58% private control
Selectivity (Barrons)	29% Non/Less competitive, 44% Competitive, 18% Very competitive, 9% Highly/Most competitive
Size	12% Very small, 37% Small, 32% Medium, 17% Large, 3% Not classified/special
Undergraduate Research (Emphasis)	The average institution-level emphasis on undergraduate research is 2.62 (between *Somewhat Important*=2 and *Important*=3)
Undergraduate Research (Time)	The average institution-level percent of faculty that spend at least some time researching with undergraduates is 57%

Table 2 HGLM Model Predicting Student Participation in Undergraduate Research (Full Model)

	Coef.	S.E.	Sig.		Coef.	S.E.	Sig.
Intercept	-3.715	.226	***				
Institution Characteristics				***Student Characteristics***			
Carnegie Classification				**Major Field (STEM)**	.645	.024	***
Doctoral	*reference group*			**Grades**			
Master's	-.102	.040	*	Mostly Cs	*reference group*		
Baccalaureate	-.039	.055		Mostly Bs	.342	.042	***
Private	-.011	.037		Mostly As	.790	.049	***
Selectivity				**Athletic Membership**	-.055	.035	
Less Comp.	*reference group*			**Frat/Soro Member**	.120	.029	***
Competitive	.055	.039		**Age (24 years or older)**	-.260	.030	***
Very Comp.	.076	.048		**Citizenship (U.S.)**	.108	.039	**
Highly Comp.	.224	.061	***	**Full-Time Enrolled**	.394	.034	***
Size				**First-Generation**	-.128	.018	***
Very Small	*reference group*			**Race**			
Small	-.064	.079		White	*reference group*		
Medium	-.205	.089	*	Asian	.167	.042	***
Large	-.307	.095	***	Black	.268	.038	***
Other	-.352	.128	**	Latino	.194	.037	***
Aggregate Faculty Importance Placed on Research	.651	.093	***	Other	.189	.031	***
Aggregate Faculty Time Spent on Research	1.158	.188	***	**Female**	-.132	.023	***
				Living on Campus	.067	.025	**
				Transfer	-.319	.021	***
				Online Education	-.425	.061	***

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$. Level-2 variance from null model = 0.294. ICC = 0.026. Reliability estimate=.833.

Table 3 HGLM Model Predicting Faculty Spending At Least Some Time on Undergraduate Research (Full Model)

	Coef.	S.E.	Sig.		Coef.	S.E.	Sig.
Intercept	.303	.124	*				
Institution Characteristics				***Faculty Characteristics***			
Carnegie Classification				**Academic Disc. (STEM)**	.001	.030	
Doctoral	*reference group*			**Rank**			
Master's	.009	.051		Full Professor	*reference group*		
Baccalaureate	.115	.077		Associate Professor	-.074	.033	*
Private	-.072	.052		Assistant Professor	-.289	.040	***
Selectivity				FT Lecturer/Instr	-.900	.057	***
Less Comp.	*reference group*			PT Lecturer/Instr	-.942	.064	***
Competitive	.128	.046	**	**Age (55 years or older)**	-.195	.026	***
Very Comp.	.274	.067	***	**Citizenship (U.S.)**	.066	.046	
Highly Comp.	.569	.099	***	**Course Load**	.041	.005	***
Size				**Doctorate Degree**	.238	.032	***
Very Small	*reference group*			**Race**			
Small	-.156	.098		White	*reference group*		
Medium	-.193	.108		Asian	.270	.057	***
Large	-.184	.119		Black	.363	.059	***
Other	-.435	.149	**	Latino	.264	.069	***
				Other	.243	.037	***
				Female	-.147	.023	***
				Years Teaching (15 plus)	-.080	.031	*

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$. Level-2 variance from null model = 0.157. ICC = 0.007. Reliability estimate=.689.

Table 4 HLM Model Predicting the Importance Faculty Placed on Undergraduate Research (Full Model)

	Coef.	S.E.	Sig.		Coef.	S.E.	Sig.
Intercept	2.581	.058	***				
Institution Characteristics				***Faculty Characteristics***			
Carnegie Classification				**Academic Disc. (STEM)**	.258	.011	***
Doctoral	*reference group*			**Rank**			
Master's	.030	.023		Full Professor	*reference group*		
Baccalaureate	.047	.035		Associate Professor	-.068	.014	***
Private	-.038	.024		Assistant Professor	-.049	.016	**
Selectivity				FT Lecturer/Instr	-.082	.021	***
Less Comp.	*reference group*			PT Lecturer/Instr	-.048	.021	*
Competitive	.033	.024		**Age (55 years or older)**	-.059	.012	***
Very Comp.	.053	.031		**Citizenship (U.S.)**	.206	.021	***
Highly Comp.	.130	.039	***	**Course Load**	-.014	.002	***
Size				**Doctorate Degree**	.180	.013	***
Very Small	*reference group*			**Race**			
Small	-.008	.045		White	*reference group*		
Medium	.025	.051		Asian	.140	.024	***
Large	-.046	.054		Black	.360	.027	***
Other	-.086	.088		Latino	.338	.030	***
				Other	.049	.015	**
				Female	-.086	.010	***
				Years Teaching (15 plus)	-.077	.012	***

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$. Variance components of the null model: level-1=.869, level-2 =.043. ICC=.047. Reliability estimate=.741.

Appendix A
Student-Related Variable Information

Student-Level Characteristics	
Undergraduate Research	Have done work on a research project with a faculty member outside of course or program requirements=1; Plan to do, do not plan to do, or have not decided=0
Age	24 or older=1; 23 or younger=0
Athletic Membership	Student athlete=1; Not a student athlete=0
Citizenship	International or foreign national=1; US citizen=0
Full-Time Enrolled	Full-time enrollment=1; Part-time enrollment=0 (Institution reported)
First-Generation Status	No parent has a baccalaureate degree=1, At least one parent has a baccalaureate degree=0
Fraternity/Sorority Membership	Member of a social fraternity or sorority=1; Not a member=0
Female	Female=1; Male=0 (Institution reported)
Grades	What most of their grades have been up to now at this institution=1; A=A, A-; B=B+, B, B-; C=C+, C, C- or lower *Mostly Cs served as reference group*
Living On Campus	Dormitory, other campus housing, fraternity or sorority house=1; Residence within walking or driving distance, none of the above=0
Major Field	In a science, technology, engineering, or math (STEM) major=1; not in a science, technology, engineering, or math (STEM) major=0
Online Education	Taking all courses entirely online=1; Not taking all courses entirely online=0
Race/Ethnicity	In group=1; Not in group=0; Asian=Asian, Asian American, or Pacific Islander; Black=Black of African American; White= White (non-Hispanic); Latino=Mexican, Mexican American, Puerto Rican, Other Hispanic or Latino; Other=American Indian, other Native American, Multiracial, Other, I prefer not to respond *White served as reference group*
Transfer	Started college elsewhere=1; Started college at current institution=0

Appendix B
Faculty-Related Variable Information

Faculty-Level Characteristics	
Undergraduate Research (Emphasis)	Importance placed on undergraduates at their institution working on a research project with a faculty member outside course or program requirements ; 1=Not important, 2=Somewhat important, 3=Important, 4=Very important
Undergraduate Research (Time)	At least some time researching with undergraduates=1, No time spent researching with undergraduates=0
Academic Discipline	In a science, technology, engineering, or math (STEM) field=1; not in a science, technology, engineering, or math (STEM) field=0
Academic Rank	In group=1; Not in group=0; Assoc=Associate Professor; Asst=Assistant Professor; Ftlect=Full-time lecturer or instructor, Ptlect=Part-time lecturer or instructor; Full=Professor *Full professors served as reference group*
Age	55 or older=1; 54 or younger=0
Citizenship	Permanent (immigrant visa) or temporary resident of the US=1; US citizen=0
Course Load	Number of graduate or undergraduate courses have taught/will teach this academic year (response options range from 0 to 18 or more)
Doctorate Degree	Highest degree earned is a doctoral degree or professional degree=1; Highest degree earned is Associate's, Bachelor's, Master's, or other degree=0
Race/Ethnicity	In group=1; Not in group=0; Asian=Asian, Asian American, or Pacific Islander; Black=Black of African American; White= White (non-Hispanic); Latino=Mexican, Mexican American, Puerto Rican, Other Hispanic or Latino; Other=American Indian, other Native American, Multiracial, Other, I prefer not to respond *White served as reference group*
Female	Female=1; Male=0
Years Teaching	15 or more years of teaching experience=1; 14 or less years of teaching experience=0

Appendix C
Institution-Related Variable Information

Institution-Level Characteristics	
Carnegie Classification	In group=1; Not in group=0; Doctoral=Doc RU-VH, Doc RU-H, Doc DRU; Masters=Masters-L, Masters-M, Masters-S; Bacc=Bac-AS, Bac-Diverse, Other *Doctoral left out as reference group*
Private	Private control=1; Public control=0
Selectivity (Barrons)	In group=1; Not in group=0; LessComp=Not available/special, Noncompetitive, Less competitive; Comp=Competitive, Competitive Plus; VeryComp=Very Competitive, Very Competitive Plus; HighComp= Highly Competitive, Highly Competitive Plus, Most Competitive *Less competitive institutions served as reference group*
Size	In group=1; Not in group=0; VS (Very Small)=VS4/C, VS4/R, VS4HR (<1,000 degree seeking students); S (Small)=S4/C, S4/R, S4/HR (1,000-2,999 degree seeking students); M (Medium)=M4/C, M4/R, M4/HR (3,000-9,999 degree seeking students); L (Large)=L4/C, L4/R, L4HR (at least 10,000 degree seeking students); O (Other)=Special focus institution, Not classified *Very small institutions served as reference group*
Aggregate Importance on Undergraduate Research	Aggregated faculty-level variable *fimpr05*. Represents the institution's faculty's average importance placed on undergraduate research • *fimpr05* : Importance placed on undergraduates at their institution working on a research project with a faculty member outside course or program requirements ; 1=Not important, 2=Somewhat important, 3=Important, 4=Very important *Included in the student model only*
Aggregate Time Spent on Undergraduate Research	Aggregated faculty-level variable *Zfresearc*. Represents the percentage of an institution's faculty that spend at least some time researching with undergraduates • *Zfresearc*. At least some time researching with undergraduates=1, No time spent researching with undergraduates=0 *Included in the student model only*