Employing Quasi-Experimental Methods to Relate

First-year Student Participation in Research with Faculty to Desired Outcomes

Kevin Fosnacht
Assistant Research Scientist
Center for Postsecondary Research
Indiana University School of Education
1900 East Tenth Street
Eigenmann Hall Suite 419
Bloomington, IN 47406–7512
Phone: 812.856.5824
Email: kfosnach@indiana.edu

John Zilvinskis
Research Project Associate
Center for Postsecondary Research
Indiana University School of Education
1900 East Tenth Street
Eigenmann Hall Suite 419
Bloomington, IN 47406–7512
Phone: 812.856.5824
Email: jozilvin@indiana.edu

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Abstract

Undergraduate research opportunities with faculty are becoming increasingly common and previously been found to positively influence student learning. However, the literature on this activity is generally weak methodologically and/or is not generalizable. This study uses quasi-experimental methods to examine the influence of research with faculty using a large national sample. We found that research with faculty experiences had significant and positive effects on multiple aspects of student engagement for a sample of first-year students, particularly student-faculty interaction. Additionally, we found differential effects of undergraduate research participation between STEM and non-STEM majors. Implications for policy and practice are discussed.

Employing Quasi-Experimental Methods to Relate First-year Student Participation in Research with Faculty to Desired Outcomes

Undergraduate research opportunities with faculty are a mainstay within higher education as evident by almost one-in-four students having participating in these experiences at some point in their undergraduate career (NSSE, 2015) and the hundreds of institutions that develop and promote these opportunities (The Council for Undergraduate Research, 2016). State postsecondary agencies like those in New York, California, and Pennsylvania have allocated resources to specifically develop these experiences at public institutions (MacLachlan & Caplan, 2015; Moran, Wells, & Smith-Aumen, 2015; O'Donnell et al. 2015). The adoption of undergraduate researcher experiences has been prompted by researchers who have identified numerous educational gains associated with student participation in undergraduate research, such as research skills (Bauer & Bennett, 2008), critical thinking abilities (Seymour, Hunter, Laursen, & DeAntoni, 2004), and heightened performance in graduate school (Gilmore, Vieyra, Timmerman, Feldon, & Maher, 2015). However, the generalizability of these studies is limited as many only include students at few institutions. Meanwhile, other researchers who have considered undergraduate research as a High-Impact Practice (HIP) used data from students attending multiple institutions, but the analyses often employ regression models that are subject to self-selection bias (e.g., Kilgo, Sheets, & Pascarella, 2014; Kuh, 2008). In response, we sought to fill this literature gap by employing a quasi-experimental technique to a national dataset and explore the relationship between first-year undergraduate student participation in research with faculty and student engagement.

Undergraduate Research

Two main components distinguished undergraduate research programs: 1) undergraduate students creating new knowledge and 2) collaboration with faculty members (The Council for Undergraduate Research, 2016). Currently, approximately 650 institutions have implemented formal undergraduate research programs (The Council for Undergraduate Research, 2016). Results from the National Survey of Student Engagement (2016) indicate that only five percent of first-year students have participated in research with faculty, a much smaller proportion compared with seniors (24%). Participation rates vary based on student identity; for example, 25% of white seniors conducted a research project with faculty, whereas only 18% of Black or African American participated. These differences indicate that the participation disparities identified by Hu, Scheuch, Schwartz, Gayles, and Li (2008) persist.

Numerous studies have related participation in undergraduate research with desired student outcomes. In their systematic analysis of the higher education literature, Pascarella and Terenzini (2005) identified undergraduate research programs as, "innovations intended to capitalize on conditions known to promote student learning" (p. 406).. Researchers have examined the positive relationship between an undergraduate research experience's rigor and the development of research skills, such as crafting research questions, analyzing test results, and explaining experimental findings (Bauer & Bennett, 2008; Buckley, Korkmaz, & Kuh, 2008; Craney, McKay, Mazzeo, Morris, Prigodich, & De Groot, 2011).

Beyond skills as a researcher, previous research correlated undergraduate research participation to personal development. Using data collected as part of the Wabash National Study of Liberal Arts Education, Barber, King, and Magolda (2013) analyzed qualitative interviews of thirty undergraduate students regarding educational experiences related to their development of self-authorship or "the internal capacity to define one's beliefs, values, identity, and social relations" (p. 868). Participants reported that undergraduate research experiences promoted skills related to self-authorship as these experiences required meaningful contributions guided by problem solving and autonomous thought. Other research on student gains related to participation in undergraduate research include increased confidence, critical thinking, and problem solving skills (Seymour et al., 2004), development of communication skills (Carter, Ro, Alcott, & Lattuca, 2016), and socialization into the science fields (Hunter, Laursen, & Seymour, 2007).

The findings from the scholarship on undergraduate research indicate that these experiences yield benefit to participating students while providing institutions with an opportunity to fulfill goals of their mission beyond enhancing student success, such as an increase of support for underserved students. For example, the California State University (CSU) System incorporated undergraduate research as a means to support underserved student populations by enhancing these experiences with support programs, quality mentoring, and funding for students (O'Donnell, Botelho, Brown, González, & Head, 2015). Researchers at the University of California, Davis correlated undergraduate research participation and an increased likelihood for completing a biology degree for African American and Hispanic students (Jones, Barlow, & Villarejo, 2010).

Undergraduate research opportunities may play an important role in improving STEM pipeline issues, as participating in this experience has been related to persistence in science fields (Schultz, Hernandez, Woodcock, Estrada, Chance, Aguilar & Serpe, 2011), applying to enroll in a STEM graduate program (Carter, Mandell, & Maton, 2009; Eagan, Hurtado, Chang, Garcia, Herrera, & Garibay, 2013), graduate school preparation (Craney, McKay, Mazzeo, Morris, Prigodich, & De Groot, 2011), and enhanced performance in graduate school (Gilmore, Vieyra, Timmerman, Feldon, & Maher, 2015). Researchers have also examined the ways undergraduate research relate to the experience of minority students and have found promising results relating to the aspirations to stay in STEM fields (Strayhorn, 2010), career choices (Sweeney & Villarejo, 2013), and, for women of color, persistence in STEM fields (Espinosa, 2011). However, many of the studies on undergraduate research only include a limited number of institutions and are thusly difficult to generalize to the broader postsecondary landscape.

It is important to note that most scholarship on undergraduate research focuses on students in STEM fields. These studies typically reinforce the narrative that students in STEM fields who participate in undergraduate research benefit in the areas of learning, persistence, and graduate studies compared with STEM students who do not participate in undergraduate research. There are a few examples of scholars who have examined the experience of students in non-STEM fields participating in undergraduate research. Webber, Laird, and BrckaLorenz (2012) found students majoring in STEM fields were significantly more likely to participate in undergraduate research compared with their non-STEM peers. In a study of cross-discipline perceptions of undergraduate research, Craney et al. (2011) measured the experiences of over 300 students from all 30 majors of Occidental College. The findings from this study revealed differences between students majoring in a science and arts/humanities in (a) the degree to which they related their research experience with work beyond postsecondary education and (b) perceived learning achieved as a result of the experience. These two studies provide credence to a focus of our current on the differences in engagement resulting in participation in undergraduate research between STEM and non-STEM students.

Critiquing National Studies

Scholars who have considered research with faculty as a HIP, alongside activities and programs like study abroad, service-learning, first-year seminars and internships, often employ student survey data from hundreds of institutions. In the cornerstone report, *High-impact educational practices: What they are, who has access to them, and why they matter*, Kuh (2008) used NSSE data to uncover the positive relationship between seniors participating in undergraduate research and deep learning behavior along with perceived learning gains. In a similar study using data form the Wabash National Study of Liberal Arts Education, Kilgo, Sheets, and Pascarella (2014) related participation in undergraduate research with positive effects on students' intercultural effectiveness and critical thinking. However, both of these studies employ traditional regression analysis, which allows for correlational, not causal inference.

Although these researchers were careful to only articulate the *relationship* between participation and outcomes, the wide adoption of HIPs suggests that practitioners and policymakers suggests that the existing evidence on HIPs supports a causal claim for the efficacy of HIP programs and practices. Educational practitioners and policy makers should care about this discrepancy as studies linking participation in HIPs and student outcomes are vulnerable to self-selection bias. To date, few studies have utilized experimental or quasi-experimental techniques to account for student self-selection in HIPs. Consequently, in this study we sought to overcome the limitations of prior studies by analyzing a multi-institutional sample using a potential outcomes framework to create counterfactual conditions to account for self-selection effects, a distinct contribution compared to the previous research which does not address this concern. Results from these efforts will produce more robust evidence of the causal relationship between participating in undergraduate research (the treatment) and student outcomes.

Conceptual Framework

Previous research on student engagement guided the current study's model specification. Initial conceptualization of student engagement includes Pace's (1980) "quality of effort" concept which relates student effort to desired outcomes and Astin's (1984) Student Involvement Theory which, similarly, relates student involvement in academic and co-curricular pursuits to similar ends. Chickering and Gamson (1987) provided concrete examples of engagement such as student-faculty interaction, prompt feedback, and high expectations. For the purposes of the current study, we utilize a more contemporary understanding of student engagement, defining the concept as the amount of time and effort students put toward educational activities both inside and out of the classroom (Kuh, 2009). Additionally, this more recent understanding of student engagement highlights the role of institutions in promoting engagement through its curriculum, programmatic offerings, and culture; thus shifting the concept from a student-centered activity to a shared student and institutional activity. Participating in undergraduate research constitutes an opportunity to satisfy these aspects of engagement while achieving goals associated with student success, like increases in perceived learning and overall engagement (Kuh, 2008).

We were also informed by Rubin's causal model also known as the potential outcomes framework (Holland, 1986; Morgan & Winship, 2007; Rubin, 1974, 1977). The model defines the treatment effect as the difference between when an individual receives and does not receive a treatment. The potential outcomes framework highlights the importance of the counterfactual, an alternative state where an individual is exposed to a different treatment condition than the condition observed. However, the counterfactual is known as the fundamental problem of causal inference as it is frequently not observed. Consequently, the counterfactual condition can be conceptualized as missing data problem. While the traditional random assignment study can use randomization to create equivalent treatment and control groups, treatment effect estimation is more difficult in observational research individuals and students self-select their environments.

Research Questions

Guided by student engagement theory and the potential outcomes framework, we investigated the following research questions to assess the efficacy of undergraduate research experiences for bachelor's-seeking first-year students:

1. How does participation in research with faculty influence bachelor's-seeking first-year students' engagement, and perceived learning?
2. Does the estimated effect of participation vary between STEM and non-STEM majors?

Methods

Data

To answer our research questions, we utilized data from a sample of first-year students who responded to two large multi-institution surveys: the 2013 Beginning College Survey of Student Engagement (BCSSE) and the 2014 National Survey of Student Engagement (NSSE). BCSSE is administered to students prior to starting college, typically during orientation, and asks about students' high school experiences and expectations for college. NSSE is administered during the following spring and inquires about students college experiences. The BCSSE-NSSE sample had the advantages of being longitudinal and multi-institutional, which allows us to improve on the existing research. In particular, BCSSE contained a number of items that functioned as pre-test measures for our outcome variables, which allowed us to improve our prediction models. We excluded from our sample students who did not enroll full-time, were international, did not attend an institution classified in one of the Carnegie Classification's primary bachelor's-granting institutions, or did not respond to the research with faculty item on

NSSE. Additionally, we dropped from our sample students enrolled at institutions where less than 5% of the sample performed research with faculty as we sought to focus on institutions where students frequently participate in undergraduate research with faculty.

After accounting for these exclusions, we had an analytic sample size of 4,401 first-year students who attended 46 institutions. The response rate to NSSE was 23%. The response rate for BCSSE was unavailable as the survey is self-administered by institutions and population files are not collected. However, as BCSSE is usually administered via paper surveys during orientation the response rate is believed to be very high (>90%). Table 1 contains the sample characteristics by research with faculty participation. Roughly, two-thirds of the sample was female. About 3 in 4 students were White. Approximately two-thirds of the sample had a parent who earned a college degree. About a quarter of the sample were STEM majors, however this proportion varied by research with faculty participation. One in four students attended doctoral universities, 44 percent attended master's colleges and universities, and a third attended baccalaureate colleges. About two in three students attended institutions with undergraduate enrollments between 1,000 and 4,999 students. Finally, about two-thirds of the sample attended private institutions.

Our key variable was a dummy variable indicating if the student "work[ed] with a faculty member on a research project." This variable was captured on NSSE during the spring of their first college year. Our dependent variables were the 10 NSSE Engagement Indicators (EIs). Information on the validity and reliability of EIs is available in the NSSE Psychometric Portfolio (National Survey of Student Engagement, n.d.). We standardized all of the outcome variables with a mean of 0 and standard deviation of 1, so that the estimated treatment effects are expressed in effect sizes.

Table 1.
Sample characteristics by research with faculty participation

	Non-participant	Participant	Total
Sex			
Female	69	65	68
Male	31	35	32
Race/ethnicity			
White	73	75	72
Asian	4	4	4
Black	6	6	6
Hispanic	5	5	6
Multiracial	11	10	11
Other	<1	<1	<1
Parental Education			
Less than high school	2	3	2
High school	22	18	22
Some college	9	7	9
Associate's	9	8	9
Bachelor's	28	32	27
Master's	21	22	21
Doctoral or professional	10	11	9
STEM major			
Not-STEM	74	62	73
STEM	26	38	27
Carnegie Classification (aggregated)			
Doctoral universities	22	24	24
Master's colleges/univ.	44	38	44
Baccalaureate colleges	33	38	33
Undergraduate Enrollment			
<1,000	5	6	5
1,000-2,499	33	32	32
2,500-4,999	32	42	32
5,000-9,999	16	10	15
>10,000	14	11	15
Institutional Control			
Public	31	23	32
Private	69	77	68
N	4093	308	4401

N*ote*: Values are percentages. Percentages may not equal 100 due to rounding.

The potential outcomes framework and previous research on undergraduate research participation and the Engagement Indicators guided our covariate selections. However, we did not include variables that could be affected by participating in research with faculty (Wooldridge, 2005). Although most research has found limited relationship between student demography, undergraduate research, and desired student outcomes; a few research projects have found significant, but small, effects for student gender (Craney, McKay, Mazzeo, Morris, Prigodich, & De Groot, 2011), race (Carter, Mandell, & Maton, 2009), and involvement in extracurricular activities (Carter, Ro, Alcott, & Lattuca, 2016). In another study using NSSE data to measure participation in undergraduate research for over 110,000 seniors, the researchers found significant effects based on gender, first-generation status, majoring in STEM fields, belonging to a fraternity or sorority and living on campus (Webber, Laird, & BrckaLorenz, 2012). We also utilized data from BCSSE to account for students' high school engagement and expectations for their first-year college experience. These variables known as the BCSSE Scales were measured prior to enrolling in college and were create to align with and predict the NSSE EIs. Consequently, the BCSSE Scales function as pre-test measures of student engagement. Information on the psychometric properties of these variables is available in Cole and Dong (n.d.). Additionally, student scores on the NSSE EIs vary by a number of groups including sex, race, parental education, standardized test score (SAT/ACT), expected major, institutional control, institutional selectivity, and institutional size and consequently we utilized these variables in our analyses (National Survey of Student Engagement, 2016).

Analyses

The potential outcomes framework guided our analyses as we sought to improve on previous research and obtain more causal and robust estimates of the effectiveness of undergraduate research during the first-year on student engagement. We chose to utilize the regression adjustment estimator to create the potential means of our outcome variables for participants and non-participants. We chose to use the regression adjustment estimator as the previous research discussed above indicates that we would be better able to predict students scores on the Engagement Indicator than to predict their probability of participation for research with faculty. Consequently, we would unable to meet the assumptions of other quasi-experimental techniques like propensity scores (Wooldridge, 2010).

The regression adjustment estimator takes a two-step estimation approach that first fits separate regression models for the treated and non-treated group and then applies the regression equation to the full sample to create the potential outcomes means. The estimated average treatment effect is then simply the difference between the mean of the two predictions. We utilized the teffects ra package in Stata 14 to estimate the models as it uses a method of moments estimator that efficiently produces valid standard errors that account for the multi-step process of the regression adjustment estimator.

For each of the outcome variables we used the following procedure to estimate the average treatment effects of participating in undergraduate research during the first college year. First, we constructed an OLS regression model that predicted the outcome variable. This step was automated using the bfit user-written command for Stata (Cattaneo, Drukker, & Holland, 2013). The bfit command fits a series of candidate regression models that include various combinations of main effects, interaction terms, and polynomials using the covariates identified above. Then we identified the best possible model by selecting the model with the lowest Bayesian information criterion (BIC). We used the BIC to identify the best possible model rather than the R^2, log likelihood, and Akaike information criterion (AIC) as they can be sensitive to overfitting the data (Cattaneo et al., 2013; Wooldridge, 2005). Next, we simply applied the best model to the regression adjustment estimator to calculate the average treatment effects, conditional on the covariates. Additionally, we applied the same procedures to answer the second research question; however, we ran the analyses for STEM and non-STEM students separately. We focused on this subgroup analysis due to the tendency of ATEs to mask heterogeneity in effects by different student types (Harris & Goldrick-Rab, 2012).

Results

Table 2.

Estimated average treatment effects of research with faculty participation during the first year

	ATE	SE	Sig.
Higher-Order Learning	.28	.06	.000
Reflective & Integrative Learning	.31	.06	.000
Quantitative Reasoning	.38	.07	.000
Learning Strategies	.20	.07	.003
Collaborative Learning	.38	.06	.000
Discussions w/ Diverse Others	.20	.06	.002
Student-Faculty Interaction	.69	.07	.000
Effective Teaching Practices	.11	.07	.092
Quality of Interactions	.08	.07	.234
Supportive Environment	.25	.07	.000

Notes: ATE = Average Treatment Effect. Results expressed as effect sizes.

We applied the procedures above to our analytic sample. Table 2 summarizes the results for our first research question: How does participation in research with faculty influence bachelor's-seeking first-year students' engagement, and perceived learning? The results indicate that research with faculty participation generally has a significant and positive relationship with various student engagement measures. The strongest estimated effect size was for Student-Faculty Interaction at .69 SD. The estimates for Reflective & Integrative Learning, Quantitative Reasoning and Collaborative Learning ranged between .30 and .39 SDs. Additionally, the estimated effect sizes for Higher-Order Learning, Learning Strategies, Discussions with Diverse Others, and Supportive Environment were between .20 and .29 SDs. The results for Effective Teaching Practices and Quality of Interactions were not significant at $p < .05$.

Table 3.

Estimated average treatment effects of research with faculty participation during the first college year by STEM major

	ATE	SE	Sig.
STEM			
Higher-Order Learning	.27	.09	.004
Reflective & Integrative Learning	.25	.08	.003
Quantitative Reasoning	.48	.09	.000
Learning Strategies	.10	.10	.339
Collaborative Learning	.36	.09	.000
Discussions w/ Diverse Others	.04	.09	.703
Student-Faculty Interaction	.69	.10	.000
Effective Teaching Practices	.03	.10	.727
Quality of Interactions	.04	.11	.751
Supportive Environment	.27	.11	.018
Non-STEM			
Higher-Order Learning	.31	.12	.008
Reflective & Integrative Learning	.42	.12	.000
Quantitative Reasoning	.36	.12	.004
Learning Strategies	.33	.11	.003
Collaborative Learning	.43	.11	.000
Discussions w/ Diverse Others	.39	.10	.000
Student-Faculty Interaction	.76	.12	.000
Effective Teaching Practices	.09	.12	.454
Quality of Interactions	.07	.11	.518
Supportive Environment	.13	.11	.229

Notes: ATE = Average Treatment Effect. Results expressed as effect sizes.

Table 3 contains the estimated average treatment effects for STEM and non-STEM students. As shown in the top panel of Table 3, the largest estimated effect of undergraduate research among STEM majors was for Student-Faculty Interaction at .69. The estimates for Quantitative Reasoning, and Collaborative Learning ranged between .30 and .49 SDs. The estimates for Higher-Order Learning, Reflective & Integrative Learning, and Supportive Environment fell between .20 and .29 SDs. The ATEs for Learning Strategies, Discussions with Diverse Others, Effective Teaching Practices, and Quality of Interactions were less than .20 SDs and nonsignificant at $p < .05$.

The bottom panel of Table 3 presents the results for students who did not expect to major in STEM field. The largest estimate was for Student-Faculty Interaction at .76 SDs. The estimates for Higher-Order Learning, Reflective & Integrative Learning, Quantitative Reasoning, Learning Strategies, Collaborative Learning, and Discussions w/ Diverse Others fell between .30 and .49 SDs. However, the estimated effect sizes for Effective Teaching Practices, Quality of Interactions, and Supportive Environment were all less than .20 SDs and non-significant.

Discussion

Undergraduate research experiences have become an important programmatic offering to improve students' learning and development, particularly at research universities. Research with faculty experiences are not only designed and implemented by impassioned institutional educators, but they have also received attention from regional and state policy makers and federal funding agencies, such as the National Science Foundation (MacLachlan & Caplan, 2015; Moran, Wells, & Smith-Aumen, 2015; O'Donnell et al. 2015). Although Kuh (2008) used NSSE data to relate participation in undergraduate research to student engagement, the current study improves on his analyses by employing a previously untapped quasi-experimental method. Furthermore, we examined research with faculty for students in non-STEM majors, which is often overlooked in scholarship on this topic. The findings from this study can be used to provide more evidence of the effects of participating in this High-Impact Practice as related to student engagement, while also providing some guidance for future research in this area.

Of the ten Engagement Indicators included as outcomes in our study, participation in research with faculty had a significant ($p > 0.01$) and positive Average Treatment Effect (ATE) for eight Engagement Indicators. Previous research on the distribution of effect sizes from the NSSE Engagement Indicators recommends classifying effects sizes smaller than .10 as trivial, .10 to .29 as small, .30 to .49 as medium, and .50 or above as large (Rocconi & Gonyea, 2015). Consequently, most of the effect sizes should be classified as small, with Reflective & Integrative Learning, Quantitative Reasoning, and Collaborative Learning considered to have medium effect sizes. These results indicate that while faculty research experiences positively influence student engagement on average, they do not have an overwhelming and dramatic influence on the first-year student experience. However, the estimate for Student-Faculty Interaction exceeded the .50 cut-off for large effects, suggesting that research experiences are an excellent method to promote relationships between students and faculty outside of the classroom.

A notable finding of interest was the difference in the estimated effect of undergraduate research participation by STEM major. Most compelling was the difference in estimated effects for Discussions with Diverse Others where STEM students had a trivial and non-significant effect size (.04), but non-STEM students had a significant and medium effect size (.39). Therefore, non-STEM students appear to have greater gains in their discussions with diverse others from participating in undergraduate research than their STEM major peers. Additionally, the estimated effect sizes for Reflective & Integrative Learning and Learning Strategies were over tenth of a standard deviation higher for non-STEM students. However, the estimated effect sizes for Quantitative Reasoning and Supportive Environment were at least a tenth of a standard deviation higher for STEM students. These differential effects indicate that undergraduate research experiences function differently by student major leading to different types of effects.

Additionally, the relationships suggest that non-STEM students engage with perspectives that challenge and/or open up their worldview during their research experience that may facilitate interactions and discussions with a diverse set of peers. However, STEM research experiences appear to promote quantitative literacy and increase students perceptions that they are supported by their institutions.

Limitations

At least three constraints on this research project are helpful to understand when framing the limits of this study. First, although our methodology allows for a stronger claim of causality between the treatment of participation in research with faculty and the outcome of student engagement, our study is still vulnerable to issues of self-selection primarily due to omitted variable bias. Although, we attempted to address this limitation to the greatest extent possible by utilizing a longitudinal dataset that included pre-test measures captured prior to the start of classes. However, it should be noted that study designs, such as randomized control trials, may not be appropriate for treatments such as participation in undergraduate research due to ethical considerations. As Hu et al. (2008) warn, participation in research with faculty require several conditions that might not be present for all students; therefore, the assumption that undergraduate research is universally beneficial may be unfounded.

Second, some researchers have vocalized concerns with student reported data. The most cited criticisms of survey data use and the NSSE in particular can be found in the fall 2011 edition of the *Review of Higher Education,* in which Porter (2011) challenged the validity of student response to NSSE items and self-reported data. However, as evident by our use of survey data, we agree with McCormick and McClenney (2012, p. 319), "We believe that imperfect information has greater decision utility than no information, and we readily acknowledge that survey research is imperfect."

Third, the constraints of secondary data analysis allows us to examine only a limited aspect of undergraduate research: participation. However, there are numerous components of research with faculty related to fidelity of implementation and quality of execution. For example, Kuh, O'Donnell and Reed (2013) argue that aspects such as interaction with faculty, collaboration with peers, student effort and other aspects of High-Impact Practices are essential for well-developed programs. Although our study relates undergraduate research with similar engagement outcomes, we are uncertain of the degree to which these aspects were present within the research experience itself. These limitations serve as a guide on the ways a consumer of this research may interpret and use its findings; however, despite these guideposts, we believe the current study contributes substantially to the field's understanding of the benefits of undergraduate research.

Future Research

In the current study, we know little about the ways in which the quality of experience for students participating in research with faculty relates to overall engagement. More detail how aspects of the experience (like faculty feedback, peer collaboration, and student effort) relate to overall student engagement could help guide campus implementation of undergraduate research initiatives. It would not be surprising to learn that students who work closely with faculty on a research project also report high levels of Student-Faculty Interaction overall. It would be interesting to know how collaboration with peers on a research project guided by a faculty member relates to overall engagement in the areas of Discussion with Diverse Others or Quality of Interaction. Also, measuring the relationship between student effort in undergraduate research and the outcomes of overall engagement as represented by High-Order Learning or Reflective & Integrative Learning behaviors could produce new insights. Future research exploring the relationship between what makes an undergraduate research experience yield higher levels of overall engagement would be useful for educators and policy makers designing these opportunities with the goal of increasing student engagement.

The secondary finding of our study, non-STEM students who participate in undergraduate research report higher gains in engagement compared with their STEM majoring peers, adds to the literature on the differences in experience between non-STEM and STEM students. What differences in the experience of non-STEM undergraduates lead students to report higher levels of engagement in the areas of Discussions with Diverse Others, Reflective & Integrative Learning, and Learning Strategies compared to non-STEM majors? How can aspects of non-STEM research experience be emulated in STEM field to produce similar gains for all students? As our review of the literature points out, a majority of scholarship is focused on STEM research experiences; however, scholars are overlooking the potent practice of non-STEM research opportunities.

Implications for Practice

The employment of the quasi-experimental method in this study allows for more confidence in declaring the positive relationship between first-year student participation in undergraduate research and student engagement. Furthermore, the description of the effect sizes indicates that although undergraduate research is tentatively linked with most aspects of engagement, it is most strongly related to Student-Faculty Interaction. Therefore, campus stakeholders who want to increase the level of interaction between students and faculty should consider resourcing opportunities for undergraduate research experiences. Campus stakeholders and governmental policy makers may frequently consider research with faculty with a focus on STEM majors; however, this would be a mistake as our research has shown greater gains in some engagement measures for students who major in non-STEM fields. Educators should be sure to challenge the STEM dominant perspective of undergraduate research, while confidently asserting the value of these experiences for non-STEM students.

Results from this study are important for policy makers who justify the use of state appropriations to subsidize system implementation of undergraduate research, while also providing an example of how to conduct quasi-experimental methods for institutional researchers to validate the resourcing of these opportunities. In the spring 2015 volume of *New Directions for Higher Education,* the issue focused on state systems' approaches to implementing undergraduate research within the curriculum of public institutions. In the chapters describing the process for institutions in California, Pennsylvania, and the City University of New York the authors cited the often touted – but methodologically limited research – relating participation in undergraduate research a desired student outcomes as central reasons to direct attention and funding (MacLachlan & Caplan, 2015; Moran, Wells, & Smith-Aumen, 2015; O'Donnell et al. 2015). The quasi-experimental methods used in this research provide a more accurate depiction of the extent that participation in undergraduate research relates to desired student outcomes than previous research efforts.

This study also provides a blueprint for Institutional Research (IR) professionals who are often in charge of measuring the effects of participation in undergraduate research and may work with student survey data like the NSSE. In a study of the role of IR professionals in measuring the influence of undergraduate research, Webber (2011, p. 706) lists the measurement of "changes in self-reported quality of effort and perceived gains" as a central function when trying to evaluate the success of these programs. Implementing quasi-experimental estimation techniques provides a more thorough scrutiny of data like these compared with traditional observational statistical analysis. Between high student participation, institutional investment, public policy, and scholarship on this HIP, research with faculty is garnering much interest in post-secondary education, particularly at the nation's largest institutions. Therefore, our study adds to this conversation by reasserting the relationship between undergraduate research and student engagement, while using a method that emboldens this claim.

Conclusion

In this study, we replicated previous research indicating that research with faculty experiences promote undergraduates' learning and development using data and methods that improve on existing research. Our results comport with prior research indicating that undergraduate research participation in the first-year of study increases various forms of engagement. Additionally, we found that these experiences have positive, but differential benefits between STEM and non-STEM majors. Consequently, our results suggest that undergraduate research programs should be broadened to also target non-STEM majors, if they are not included. Additionally, our finding that the effects of participation vary by major indicate that faculty can learn from one another to promote a more holistic experience for all.

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