PURM
Perspectives on Undergraduate Research and Mentoring

Participation in Undergraduate Research at Minority-Serving Institutions

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Student participation in undergraduate research activities is one important way to help achieve individual and institutional goals for student success (Kuh, 2008; Kuh, Chen, & Nelson Laird 2007). Due in large part to the Carnegie Commission report that urged reform in undergraduate education making "research-based learning the standard" (Boyer Commission Report, 1998), undergraduate research has gained prominence as a feature of the American college experience over the past 20 years. 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 (UR) has moved from 'cottage industry' to a 'movement' (Blanton, 2008).

Participation in 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 be positively associated with analytic and critical thinking (Bauer & Bennett, 2008; Kardash, 2000; Kuh, Chen, & Nelson Laird 2007; Volkwein & Carbone, 1994; Webber, Nelson Laird, & BrckaLorenz, 2013), to increase academic achievement and retention (Chang, Sharkness, Hurtado & Newman, 2014; Cole & Espinoza, 2008; Ishiyama, 2002; Nagda, Gregerman, Jonides, von Hippel, & Laursen, 1998), to clarify choice of academic major (Tompkins, 1998; Wasserman, 2000; Seymour, Hunter, Laursen, & Deantoni, 2004), and to promote enrollment in graduate school (Bauer & Bennett, 2003; Eagen Hurtado, Chang, Garcia, Herrera, & Garibay, 2013; Hathaway, Nagda, & Gregerman, 2002; Seymour et al., 2004; Lopatto, 2004; Russell, 2005). Participation in undergraduate research has been shown to provide even greater gains for traditionally underrepresented students along with aiding in underrepresented minority (URM) student retention (Jones, Barlow, & Villarejo, 2010; Chang, et al., 2014; Kinzie, Gonyea, Shoup, & Kuh, 2008).

Except for a limited number of studies (e.g., Chang et al., 2014; Eagan, et al; 2012; Espinosa, 2011; Hurtado, Eagen & Hughes, 2012), there is less comprehensive information available on the extent to which students at minority-serving institutions (MSIs) participate in UR, nor how UR affects engagement in other college activities for URM (including those who self-report as Black, Hispanic/Latino, or Native American) students. Recent documents urge more study of how to facilitate success for traditionally underserved students (Finley & McNair, 2013; Maxwell-Jolly, 1999) and how UR can aid in their success (Laursen, Hunter, Seymour, Thiry, & Melton, 2010). Because URM students, particularly Latino(a) students, have high levels of dropout (Espinoza, 2011; Nora & Cabrera, 1996), college officials need to consider how to encourage minority students' active participation in a variety of campus activities that can lead to a greater likelihood of success.

Though this research has started to explore the benefits of participating in research for URM students, it has not addressed UR in the institutional context of MSIs. MSIs constitute a variety of institutions, diverse in the populations they serve, size, Carnegie classification, and mission (Contreras & Contreras, 2015; Hurtado & Ruiz, 2006). Despite this diversity, MSIs are similar in that they contain a higher proportion of first-generation college students, have a more diverse student population, and have some level of espoused mission towards equity and diversity in education (Bridges, Cambridge, Kuh, & Leegwater, 2005). These factors make comparisons with student experiences at predominantly white institutions (PWIs) an important factor in understanding how institutional context impacts the likelihood of participating in UR and the benefits of participation. The current study is an exploratory analysis of data on 4-year PWIs and MSIs from the National Survey of Student Engagement (NSSE) to explore what factors are associated with UR participation, and how participation at MSIs effects student engagement in quantitative reasoning, collaborative learning, and development of learning strategies.

Relevant Literature

Scholars believe that students can benefit strongly from instructional practices that challenge students to think broadly across experiences, both in-class and out-of-class, reflecting on ideas and actions that require integration and inclusion of different perspectives (Entwistle, 2006; Entwistle, McCune & Walker, 2000). One of the reasons why UR enhances student learning is because it necessitates students to think broadly and synthetically, to apply concepts across different situations, and be open to new ways of thinking. During a research experience, students are engaging in deep approaches to learning, a kind of learning process that involves relating ideas and looking for patterns (a holistic approach), using available evidence, and examining the logic of arguments (Entwistle, 2006). Deep learning also involves developing one's own understanding of an issue (Entwistle, McCune & Walker, 2000). In the contrasting surface approach, students see what they learn as unrelated bits of information. Entwistle et al. believe that surface learning leads to much more restricted learning, and in particular, routine memorization. UR is classified as a high-impact practice because it promotes deep learning and facilitates collaboration between students and faculty (Kuh, 2008). Further, Kuh (2013) suggests that the integration of high-impact practices like UR into the campus culture allows students to more fully engage in their learning and connect to the campus.

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The deep learning that takes place in the context of UR helps students look for the underlying meaning of an issue, not just apparent knowledge. It encourages students to search for relationships between pieces of information that comes from reflection rather than rote memorization. UR involves applying knowledge to real-life situations and successfully integrating previous learning. To further explore the learning that takes place in an UR experience, this study uses measures of students' use of quantitative reasoning, engagement in collaborative learning, and use of learning strategies from the National Survey of Student Engagement (NSSE).

UR's Contribution to Student Learning and Success

Over the past two decades there has been increasing evidence of the benefit of participation in UR for students and for faculty members. Along with numerous articles on specific programs, books and monographs have also summarized its broad set of activities and benefits (Hu, Scheuch, Kuh, Gayles & Li 2008; Taraban & Blanton, 2008; Laursen et al., 2010). Through a variety of short- and long-term

programs, UR has been shown to have multiple benefits for students, including acquisition of analytic and synthetic thinking, increased confidence in ability to make presentations or speak publicly, and assistance with employment and/or graduate school. There is also evidence that UR can be a benefit to faculty members, both in assisting with their individual research program as well as helping faculty members accomplish the important goal of contributing to student learning (Adedokun, 2010; Eagen, Sharkness & Hurtado, 2011; Gates et al., 1999; Kardash 2000; Zydney et al., 2002).

While some earlier work focused on the effects of UR with minority populations (e.g., Nagda et al., 1998), particularly African Americans, a recent increase in funding to support minorities in academically-rich experiences has led to a number of studies documenting the growth in UR that includes or targets minority populations. For example, Clewell, et al. (2005), Maton, Hrabowski, and Schmitt (2000), and Summers and Hrabowski III (2006) found minority student participation in UR helps students pursue science-related careers. Despite the evidence of these benefits, challenges remain for increasing the number of URMs who participate in high-impact practices such as UR. In part due to concern about personal finances, Hurtado et al. (2008) found that African American students have significantly lower odds of participating in health science research during college than their White counterparts. However, when students do participate in UR, there can be benefits to undergraduate degree success, increased self-confidence, and possible enrollment in graduate school. Strayhorn (2010) found that participation in UR improved URM aspirations for attending graduate school, which may indicate a positive change in students' self-efficacy as a scientist. Although Chang et al. (2014) found that persistence in STEM majors was significantly lower for African American and Latino students, they did find that participation in UR substantially helped retain students in STEM majors. Perhaps also an indication of increased self-efficacy, Chang et al. report that URM students who participated in research programs were 17.4 percentage points more likely to persist in STEM than those who did not. While these studies provide us with some insight into today's diverse students in UR, much is yet unknown, particularly for the growing URM population. This body of research demonstrates clear benefits for students and faculty, but has largely focused on students in STEM majors. The present study will further this line of research by assessing how participation in UR at MSIs is related to effective educational practices (Kuh, 2008) and student engagement (Kuh, Kinzie, Schuh, & Whitt, 2010), specifically, how it is related to effective learning strategies, collaborative learning, and the development of quantitative reasoning.

Conceptual Framework

Astin (1984) and Pace (1983) posited that students who are more engaged in the college environment are more likely to participate in activities that enhance academic performance. Tinto (1975, 1993) proposed that students must perceive a good fit with the institution to avoid dropping out, and Pascarella (1985) purported that student outcomes are, in part, a function of the interaction of student characteristics (e.g., age, graduate school intentions, parental education) student perceptions of the environment, student interactions with peers and faculty, and student quality of effort. A number of studies have shown that participation in UR is beneficial to student achievement (e.g., Chang et al., 2014; Hu et al., 2008; Webber et al., 2013) perhaps because it encourages students to become more familiar with campus locations and services, develop friendships with peers who have similar interests, and to make connections with faculty and administrative staff.

The above theoretical frameworks are helpful, yet critics suggest that theories developed for students in prior decades must be reviewed for contemporary populations, particularly underrepresented and first-generation students. In a growing body of literature that identifies issues for Latino(a) and Black students, one topic receiving attention is the effect of support from family,

peers, and institution officials. For example, Torres (2006) found that Latino(a) students' level of academic integration contributed to students' commitment to the institution, and Cejda and Rhodes (2004) found Hispanic students' interactions with faculty to be a key factor in successful transfer to a four-year institution. The one-on-one interactions with faculty and peers gained through activities such as UR may help URM students increase their commitment to the institution, their choice of major, and level of self-efficacy as a student-scholar.

Sedlacek and colleagues (Fuertes & Sedlacek, 1994; Tracey & Sedlacek, 1987) found that positive self-concept and the availability of supportive individuals are predictive of academic success in college for minority students, and can sometimes be more important than traditional measures of cognitive ability such as the SAT. Relatedly, Allen (1999) found that African American students who engaged in social activities and reported that they were part of the institutional social environment were more likely to persist than students who remain isolated. These findings would suggest that the act of engaging in research, collaborating with other student researchers, and building connections with faculty may help students to feel more connected to campus, develop a more positive academic identity, and build more supportive connections on campus. Indeed, previous research has demonstrated a stronger impact of engaging in UR for traditionally underrepresented and first-generation students (Kinzie et al., 2008).

Studies mentioned here remind us that the needs and pathways to success for URM students may be different than that of the traditional majority student. Clearly, more research is needed that can aid in the refinement of traditional theories for today's URM students. This notion applies to URM student participation in UR as well. However, available literature affirms that URM students' success is related to an interaction between individual skills and abilities, and the perceived fit with the college environment. This study will look specifically at URM and first-generation student participation at PWIs and MSIs to gain a deeper understanding of URM participation in UR activities and to affirm or help us revise theoretical frameworks that guide our deeper understanding of student success for today's more diverse college student population.

A better understanding of academic and co-curricular activities that can assist URM students is beneficial to the students themselves as well as to achievement of institution-level goals. Faculty and staff members need to be aware of the unique needs of URM students in order to engage these students in research. Engaging traditionally unrepresented students in research provides greater engagement in deep learning and results in greater synthesis and transfer of knowledge (Booth, Luckett, & Mladenovic, 1999; Ramsden, 1992). In addition to increasing deep learning, creating greater equity in UR participation also facilitates greater equity in preparation for graduate education, particularly in STEM fields. This research speaks to increasing diversity in STEM fields but also includes students from other majors to address the broader issues of participating in research and graduate school preparation across majors.

Current Study

Factors associated with participation in undergraduate research and the effect of student participation in undergraduate research on student engagement at MSIs are examined in this current study. Data from the NSSE was used to answer the following research question for minority-serving, four-year institutions.

1. What factors are associated with UR participation, and what is the effect of participation for

students at MSIs?

a. What institution characteristics contribute to UR participation, specifically, minority serving/predominately white designations, public/private status, Carnegie classification?
b. What student characteristics contribute to UR participation at MSIs, specifically, enrollment status, age, parental education, gender, major, educational aspirations, grades, transfer status, racial/ethnic background?
c. What experiences in college contribute to UR participation at MSIs, specifically, time spent working on- or off-campus, and time spent caring for dependents?
d. Does involvement in UR contribute to intended learning outcomes as measured by engagement indicators Quantitative Reasoning, Learning Strategies, and Collaborative Learning?

Methodology

This study explores participation in undergraduate research for URM students across institution type and specifically at MSIs through a large-scale dataset. The analyses also explore the effect of engaging in research for students at MSIs.

Data

In order to examine participation in UR for URM and first-generation students, data from the 2013 administration of the National Survey of Student Engagement (NSSE) was used along with publicly available institutional data. NSSE was designed to measure the time and energy that students invest in activities that relate to student learning and development. More specifically, NSSE asks students questions about who they interact with, how they spend their time, how often they engage in various effective educational practices, the quality of their interactions in college, and their perception of campus environment. NSSE 2013 was administered to first-year and senior students at over 620 four-year colleges and universities. The average response rate was 30%. The survey is administered mid- to late-spring semester to first-year and senior students.

Sample

The sample for this study included 586 four-year institutions, 459 PWI and 109 MSI, in the U.S., resulting in 136,115 first-year and 198,693 senior student respondents. Preliminary analysis looked specifically at Historically Black Colleges and Universities (HBCUs) and Hispanic Serving Institutions (HSIs) compared to PWIs. Similar preliminary results were found between HBCUs and HSIs so further analysis was conducted on MSIs in the aggregate. The majority of students in the sample (86%) attended a PWI, with the remaining 18,247 first-years and 28,811 seniors attending an MSI. Overall, the students in this study were from a variety of majors, had mostly A or B grades, mostly of traditional college age, and about half were first-generation students. Most of the students in the sample were enrolled full-time, few were taking all of their courses online, and about two-thirds of first-year students and about 40% of the seniors were living on campus. Slightly less than half of the students overall were at privately-controlled institutions. The largest portion of students, however, was at Master's-granting institutions with larger programs. For detailed information about the characteristics of students and institutions in this study, see Tables 1 and 2.

Table 1. Percentages of Select Student Characteristics for the Overall Study Sample

		MSI (%)		PWI (%)		Total (%)	
		First-year	Senior	First-year	Senior	First-year	Senior
Major	Arts & Humanities	7	9	10	11	9	10
	Biological Sciences, Agriculture, & Natural Resources	13	8	11	9	11	9
	Physical Sciences, Mathematics, & Computer Science	5	4	5	4	5	4
	Social Sciences	12	14	11	12	11	13
	Business	16	20	14	17	14	17
	Communications, Media, & Public Relations	3	3	4	4	4	4
	Education	7	9	9	10	9	10
	Engineering	7	5	8	7	8	6
	Health Professions	15	11	15	13	15	13
	Social Service Professions	7	6	4	5	5	5
Grades	Mostly A grades	43	48	49	54	49	53
	Mostly B grades	45	46	43	42	43	42
	Mostly C grades or lower	11	6	8	5	8	5
First-generation		58	59	41	46	43	48
Gender	Female	68	67	65	63	66	63
	Male	32	33	35	37	34	37
Age	19 or younger	76	1	84	<1	83	<1
	20-23	9	44	7	60	7	58
	24-29	4	21	3	15	3	16
	30-39	5	16	3	11	3	12
	40-55	5	15	3	11	3	12
	Over 55	1	2	<1	2	<1	2
Racial/ethnic background	American Indian or Alaska Native	<1	<1	<1	1	<1	1
	Asian	8	7	5	4	6	4
	Black or African American	23	19	6	6	9	8
	Hispanic or Latino	24	23	5	4	7	7

Table 1 continued. Percentages of Select Student Characteristics for the Overall Study Sample

	Native Hawaiian or Other Pacific Islander	1	1	<1	<1	<1	<1
	White	28	35	70	73	65	68
	Other	2	2	1	1	1	1
	Multiracial	10	8	7	5	7	6
	I prefer not to respond	4	5	4	5	4	5
Educational Aspirations	Some college	4	4	6	5	5	4
	Bachelor's degree	31	28	27	27	30	28
	Master's degree	41	45	37	43	40	45
	Doctoral or professional degree	25	23	30	25	25	23
Transfer status		11	46	15	61	11	48
Social fraternity/sorority member		5	9	9	10	9	10
Living on campus		46	10	68	17	66	16
Taking all courses online		7	10	5	14	5	13
Full-time enrolled		90	75	95	82	94	81
Total Counts		**18,247**	**28,811**	**117,868**	**169,882**	**136,115**	**198,693**

Table 2. Percentages of Select Institution Characteristics for the Overall Study Sample

		MSI (%)		**PWI (%)**		**Total (%)**	
		First-year	**Senior**	**First-year**	**Senior**	**First-year**	**Senior**
Private control		48	44	40	31	47	42
Carnegie classification	Research Universities (very high research activity)	12	12	8	8	11	11
	Research Universities (high research activity)	21	24	7	10	19	22
	Doctoral/Research Universities	7	9	10	10	8	9
	Master's Colleges and Universities (larger programs)	30	32	38	40	32	33
	Master's Colleges and Universities (medium programs)	8	7	9	9	8	8

Table 2 continued. Percentages of Select Institution Characteristics for the Overall Study Sample

	Master's Colleges and Universities (smaller programs)	3	2	6	5	3	3
	Baccalaureate Colleges-Arts & Sciences	9	6	6	4	9	6
	Baccalaureate Colleges-Diverse Fields	8	6	13	12	8	7
	Other	3	2	3	2	3	2
Institution size	Special focus/very small	5	3	6	4	5	3
	Small	19	14	23	17	19	14
	Medium	31	29	39	40	32	31
	Large	45	54	33	38	44	52
Selectivity (Barrons)	Not available/special	4	7	17	14	6	8
	Noncompetitive	5	5	5	7	5	5
	Less competitive	6	6	20	23	8	9
	Competitive	43	46	42	42	43	45
	Very competitive	31	28	11	10	28	25
	Highly competitive	9	7	4	4	8	6
	Most competitive	2	2	<1	<1	2	1
Region	New England	9	7	<1	<1	8	6
	Mid East	15	13	9	7	14	12
	Great Lakes	22	18	3	2	19	16
	Plains	14	15	3	2	12	14
	Southeast	21	24	27	22	22	24
	Southwest	7	9	35	42	11	14
	Rocky Mountains	8	9	<1	<1	7	7
	Far West	4	5	21	23	7	7
	Outlying Areas	<1	<1	2	2	<1	<1

Measures

Participation in UR was compared between MSIs and PWIs. In addition, institutional characteristics used as controls included Carnegie classification and public/private control. A variety of student

demographics including declared major, grades, first-generation status, gender, age, racial/ethnic background, educational aspirations, transfer status, membership in a social fraternity/sorority, living on campus, taking courses online, and enrollment status were used as controls. Four additional items were used to examine a student's ability to participate in UR: time spent studying, time spent working on campus, time spent working off campus, and time spent caring for dependents. Three aggregate measures of engagement were examined to explore engagement relationships with UR as well: Collaborative Learning, Learning Strategies, and Quantitative Reasoning. For more information about these individual survey items and aggregate measures, see Table 3.

Table 3. Survey Items and Measures Used in this Study

Engagement Indicator	Individual Items	Alpha
Collaborative Learning	**During the current school year, about how often have you done the following:** *Very often, Often, Sometimes, Never* -Asked another student to help you understand course material -Explained course material to one or more students -Prepared for exams by discussing or working through course material with other students -Worked with other students on course projects or assignments	FY:.81 SR:.80
Learning Strategies	**During the current school year, about how often have you done the following:** *Very often, Often, Sometimes, Never* -Identified key information from reading assignments -Reviewed your notes after class -Summarized what you learned in class or from course materials	FY:.77 SR:.78
Quantitative Reasoning	**During the current school year, about how often have you done the following:** *Very often, Often, Sometimes, Never* -Reached conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.) -Used numerical information to examine a real-world problem or issue (unemployment, climate change, public health, etc.) -Evaluated what others have concluded from numerical information	FY:.85 SR:.87
Individual Items		
Undergraduate Research	**Which of the following have you done or do you plan to do before you graduate?** *Done or in progress, Plan to do, Do not plan to do, Have not decided* -Work with a faculty member on a research project	
Time spent studying	**About how many hours do you spend in a typical 7-day week doing the following?** *0, 1-5, 6-10, 11-15, 16-20, 21-25, 26-30, More than 30 (Hours per week)* -Preparing for class (studying, reading, writing, doing homework or lab work, analyzing data, rehearsing, and other academic activities)	
Time spend working on campus	**About how many hours do you spend in a typical 7-day week doing the following?** *0, 1-5, 6-10, 11-15, 16-20, 21-25, 26-30, More than 30 (Hours per week)* -Working for pay **on campus**	
Time spent working off campus	**About how many hours do you spend in a typical 7-day week doing the following?** *0, 1-5, 6-10, 11-15, 16-20, 21-25, 26-30, More than 30 (Hours per week)* -Working for pay **off campus**	
Time spent caring for dependents	**About how many hours do you spend in a typical 7-day week doing the following?** *0, 1-5, 6-10, 11-15, 16-20, 21-25, 26-30, More than 30 (Hours per week)* -Providing care for dependents (children, parents, etc.)	

For more details on the development of the NSSE Engagement Indicators see: http://nsse.iub.edu/html/reliability.cfm

Analysis

All students were included in the initial analysis of participation rates in UR across all institutions and in comparing participation at PWIs and MSIs. Comparative analysis (*t*-test) was used to compare participation rates. Cohen's *d* effect sizes were also computed. For subsequent analyses, the sample was limited to only students attending an MSI. A series of logistic regressions were used to examine factors that contribute to participation in UR (yes/no) and how participating in research is related to ways in which students spend their time (preparing for class, working, and caring for dependents). Next, a series of OLS regression equations examined the relationships between participation in UR and other forms of student engagement. Student-characteristic controls consisted of all measures in Table 1. Institution-characteristic controls were private/public control and Carnegie classification. First-year and senior data were analyzed separately in order to present distinct results reflective of the first-year and senior experiences in college. Although data in this study are nested (i.e., students within institutions), single-level analyses were used because the focus of the investigations were on student engagement and student-level measures. Testing on this survey instrument has demonstrated that when there is low institution level variance, a single level analysis does not produce significantly different results when compared to a multi-level model (Rocconi, 2013).

Findings

Participation

Though other studies report that participating in high-impact practices like UR has a compensatory effect for first-generation and URM students (Finley & McNair, 2013; Kinzie et al., 2008), the students in this study who may benefit the most reported lower rates of participation. Shown in Table 4, by their senior year, only 18% of Black and 19% of Latino(a) students reported having engaged in research with a faculty member compared to 25% of White and Asian students. Similarly, only 19% of first-generation seniors reported involvement in research with a faculty member. These patterns across institution type are also reflective of participation in undergraduate research at PWIs.

Though Black students participated at much higher rates at an MSI (15% senior participation at PWIs and 24% senior participation at MSIs), Latino(a) participation was noticeably lower than other students, at both PWIs and MSIs. In addition, first-generation student participation remained lower than other students at MSIs. These patterns across institution type are also reflective of participation in UR at PWIs.

Table 4. Percentages of Students Participating in Undergraduate Research with a Faculty Member

		MSI (%)		PWI (%)		Total (%)	
		First-year	Senior	First-year	Senior	First-year	Senior
Racial/ethnic background	Asian, Native Hawaiian, or Other Pacific Islander	5.9	25.2	7.1	25.4	6.9	25.4
	Black or African American	8.3	23.6	6.3	15.1	7.0	17.9
	Hispanic or Latino	5.3	18.6	5.8	18.9	5.6	18.8
	White	5.0	22.8	4.6	25.3	4.6	25.1
	American Indian, Alaska Native, Other	9.0	22.2	7.0	23.6	7.3	23.4
	Multiracial	5.2	26.7	5.1	26.5	5.1	26.5

Table 4 continued. Percentages of Students Participating in Undergraduate Research with a Faculty Member

I prefer not to respond to race	8.0	23.8	6.1	25.7	6.3	25.4
First-generation	6.2	19.3	5.2	19.1	5.4	19.1
Non first-generation	6.1	27.1	4.9	29.0	5.0	28.8
Overall	6.2	22.3	5.1	24.3	5.2	24.0

When combining URM students together into one aggregate group, and making comparisons between URM UR participation at PWIs and MSIs, no notable or significant differences were found (see Table 4). Since UR participation rates were largely similar between MSIs and PWIs, with the exception of higher African American participation at MSIs, and patterns of lower participation of URM and first-generation students persist across institutions, this research also explores what factors are associated with participation in UR at MSIs.

Factors Associated with Participation in Undergraduate Research at MSIs

A logistic regression equation was used to examine demographic predictors of participation in UR (First-year: $\chi^2(22) = 139.061$, $p < .001$; Senior: $\chi^2(22) = 2{,}584.507$, $p < .001$). At MSIs, the first-year students who were in a STEM major (eB = 1.224, B =.203, p =.017), aspired to a doctorate (eB = 1.592, B = .465, p < .001), received mostly A grades (eB = .1.346, B = 2.97, p = .025), who were Black or African American (compared to White) (eB = 1.561, B = .446, p < .001), and who were members of a social fraternity/sorority (eB = 1.362, B = .309, p = .048) were all significantly more likely to participate in UR (see Table 5). First-year students who were taking all of their courses online were less likely to participate in UR (eB = .535, B = -.626, p = .007). Similar factors also made students more likely to have participated in research by their senior year (see Table 5). Seniors who were enrolled full-time (eB = 1.249, B = .222, p < .001), were traditional age students (eB = 1.482, B = .394, p < .001), were female (eB = 1.131, B = .123, p = .001), were in a STEM major (eB = 2.372, B = .864, p < .001), aspired to either a Master's (eB = 1.318, B = .276, p < .001) or doctorate degree (eB = 2.518, B = .924, p < .001), received mostly As (eB = 2.016, B = .701, p < .001) or Bs (eB = 1.454, B = .375, p < .001), were a member of a social fraternity/sorority (eB = 1.219, B = .198, p = .001), and were living on campus (eB = 1.286, B = .252, p < .001) were more likely to participate in research. Senior level Black or African American students were no more likely to have engaged in research than White peers (eB = .997, B = -.003, p = .956), and Asian (eB = .849, B = -.164, p = .017) and Latino(a) (eB = .759, B = -.275, p < .001) students were less likely to engage in research than White students. Transfer status (eB = .756, B = -.279, p < .001), first-generation (eB = .889, B = -.117, p = .001), and enrollment in all online courses (eB = .325, B = -1.124, p < .001) were mitigating factors to UR participation.

Table 5. Predictors of Participation in Undergraduate Research at MSIs

	First-Year		**Senior**	
	Exp(B)	**Sig.**	**Exp(B)**	**Sig.**
Full-time enrollment	*1.396*	*.071*	**1.249**	**.000**
Traditional age	*.933*	*.609*	**1.482**	**.000**

Table 5 continued. Predictors of Participation in Undergraduate Research at MSIs

First-generation	*1.122*	*.148*	**.889**	**.001**
Female	*.951*	*.544*	**1.131**	**.001**
STEM major	**1.224**	**.017**	**2.372**	**.000**
Master's degree aspiration	*1.022*	*.829*	**1.318**	**.000**
Doctoral degree aspirations	**1.592**	**.000**	**2.518**	**.000**
Mostly A grades	**1.346**	**.025**	**2.016**	**.000**
Mostly B grades	*1.111*	*.427*	**1.454**	**.000**
Transfer student	*1.141*	*.268*	**.756**	**.000**
Asian, Native Hawaiian, Other Pacific Islander	*1.079*	*.614*	**.849**	**.017**
Black or African American	**1.561**	**.000**	*.997*	*.956*
Hispanic or Latino	*1.023*	*.849*	**.759**	**.000**
Multiracial	*1.044*	*.764*	*1.022*	*.729*
American Indian, Alaska Native, Other	*1.547*	*.065*	*.869*	*.232*
I prefer not to respond to race	**1.550**	**.017**	*1.014*	*.867*
Social fraternity/sorority member	**1.362**	**.048**	**1.219**	**.001**
Living on campus	*1.048*	*.586*	**1.286**	**.000**
Taking all courses online	**.535**	**.007**	**.325**	**.000**
Private institution	*.903*	*.242*	**1.134**	**.002**
Doctorate-granting institution	**.751**	**.018**	**.828**	**.001**
Master's-granting institution	**.713**	**.000**	**.781**	**.000**
Constant	**.035**	**.000**	**.092**	**.000**

Note: Reference groups are some college or bachelor's degree aspirations, mostly C grades, White, and Bachelor's-granting Carnegie classification.

An additional logistic regression equation examined the relationships between how students' time working on campus, working off campus, caring for dependents, and preparing for class were related to participation in UR while controlling for student demographics and institution characteristics (First-year: $\chi^2(26) = 273.203$, $p < .001$; Senior: $\chi^2(26) = 2{,}776.187$, $p < .001$). In addition to understanding how student characteristics impact UR participation, this study also explored how students spend their time on select activities influenced participation in research. During the first year of college, time spent working on (eB = 1.058, B = .056, $p < .001$) and off campus (eB = 1.011, B = .011, p = .006) as well as time spent studying (eB = 1.052, B = .051, p = .023) were positively related to participation in UR (see Table 6). For seniors, students who worked more hours off campus (eB = .995, B = -.005, $p < .001$) and students who spent more time caring for dependents (eB = .996, B = -.004, p = .014) were less likely to engage in research, though the effect of time spent

caring for dependents was only marginally significant. Time spent working on campus (eB = 1.030, B = .029, p < .001) and time spent studying (eB = 1.082, B = .079, p < .001) were still positively related to research participation in respondents in their senior year.

Table 6. Behavioral Predictors of Participation in Undergraduate Research at MSIs

	First-Year		Senior	
	e^B	Sig.	e^B	Sig.
Time spent working off campus	**1.011**	**.006**	**.995**	**.000**
Time spent working on campus	**1.058**	**.000**	**1.030**	**.000**
Time spent caring for dependents	*1.008*	*.080*	**.996**	**.014**
Time spent preparing for class	**1.052**	**.023**	**1.082**	**.000**
Full-time enrollment	1.459	.048	1.187	.000
Traditional age	1.066	.659	1.391	.000
First-generation	1.037	.655	.894	.003
Female	.987	.881	1.157	.000
STEM major	1.254	.010	2.217	.000
Master's degree aspiration	1.031	.764	1.309	.000
Doctoral degree aspirations	1.599	.000	2.392	.000
Mostly A grades	1.276	.076	1.830	.000
Mostly B grades	1.051	.714	1.377	.000
Transfer student	1.117	.368	.796	.000
Asian, Native Hawaiian, Other Pacific Islander	1.051	.747	.819	.005
Black or African American	1.570	.000	1.004	.935
Hispanic or Latino	1.024	.843	.767	.000
Multiracial	1.006	.968	1.008	.900
American Indian, Alaska Native, Other	1.454	.126	.884	.306
I prefer not to respond to race	1.531	.024	1.015	.856
Social fraternity/sorority member	1.279	.124	1.214	.001
Living on campus	1.044	.642	1.166	.005
Taking all courses online	.529	.008	.356	.000
Private institution	.848	.069	1.131	.004
Doctorate-granting institution	.707	.006	.812	.000
Master's-granting institution	.688	.000	.769	.000

Constant	.020	.000	.075	.000

Note: Reference groups are some college or bachelor's degree aspirations, mostly C grades, White, and Bachelor's-granting Carnegie classification.

Benefits of Research Participation at MSIs

With a specific focus on students at MSIs, our findings also showed that UR is significantly and positively related to key elements of student engagement at these specialty-focused institutions even while controlling for other factors that impact participation in UR. A series of OLS regression models were used to examine the relationship that participating in undergraduate research had with the three engagement outcomes Learning Strategies (First-year: R^2 = .071, F(12,658) = 41.851, p < .001; Senior: R^2 = .075, F(21,687) = 76.703, p < .001), Collaborative Learning (First-year: R^2 = .137, F(12,584) = 86.413, p < .001; Senior: R^2 = .145, F(21,610) = 159.601, p < .001), and Quantitative Reasoning (First-year: R^2 = .042, F(12,751) = 24.428, p < .001; Senior: R^2 = .058, F(21,841) = 57.965, p < .001). Controlling for background characteristic, academic performance, and educational aspirations, both first and senior year students at MSIs who participated in research with a faculty member reported using more learning strategies (First-year: B = 5.094, t(23) = 9.833, p < .001; Senior: B = 2.743, t(23) = 11.475, p < .001), increased collaborative learning (First-year: B = 7.691, t(23) = 15.253, p < .001; Senior: B = 3.776, t(23) = 16.262, p < .001), and having more experience with quantitative reasoning (First-year: B = 9.045, t(23) = 14.601, p < .001; Senior: B = 5.339, t(23) = 18.364, p < .001) than students not participating in an UR experience (see Table 7). These benefits of participating in research at MSIs stress the importance of addressing issues of unequal participation for URM and first-generation students.

Table 7. Relationships between Undergraduate Research at MSIs and Student Engagement

	Collaborative Learning				Learning Strategies				Quantitative Reasoning			
	First-Year		Senior		First-Year		Senior		First-Year		Senior	
	Unst. B	Sig.	Unst. B	Sig.	Unst. B	Sig.	Unst. B	Sig.	Unst. B	Sig.	Unst. B	Sig.
Constant	21.76	.000	24.84	0.00	37.15	0.00	34.87	.000	22.90	.000	24.90	.000
Undergraduate Research	**7.69**	**.000**	**3.78**	**.000**	**5.09**	**.000**	**2.74**	**.000**	**9.05**	**.000**	**5.34**	**.000**
Full-time enrollment	2.48	.000	3.30	.000	0.59	.255	0.96	.000	1.73	.005	2.07	.000
Traditional age	2.94	.000	2.88	.000	-3.62	.000	-3.73	.000	0.74	.176	-0.53	.062
First-generation	0.33	.198	-0.02	.920	0.72	.006	0.45	.026	0.58	.066	-0.19	.439
Female	0.48	.068	0.47	.019	2.55	.000	2.80	.000	-3.45	.000	-3.88	.000
STEM major	1.64	.000	2.03	.000	-1.01	.001	-1.93	.000	1.84	.000	3.47	.000
Master's degree aspiration	0.94	.001	0.89	.000	1.87	.000	1.87	.000	0.94	.009	1.63	.000
Doctoral degree aspirations	1.73	.000	0.82	.001	2.94	.000	3.97	.000	2.05	.000	3.12	.000
Mostly A grades	1.84	.000	0.98	.013	5.22	.000	5.17	.000	2.21	.000	1.70	.001
Mostly B grades	2.13	.000	1.56	.000	2.95	.000	3.20	.000	1.96	.000	1.78	.000
Transfer student	-0.04	.915	-0.13	.537	0.20	.606	0.70	.002	0.21	.652	0.16	.541
Asian, Native Hawaiian, Other Pacific Islander	1.94	.000	1.70	.000	-0.84	.079	-0.38	.324	2.72	.000	2.28	.000
Black or African American	2.23	.000	2.17	.000	1.70	.000	2.44	.000	2.57	.000	2.02	.000
Hispanic or Latino	0.98	.006	1.47	.000	-1.03	.004	0.01	.957	0.29	.506	1.34	.000
Multiracial	1.42	.001	0.81	.023	-0.74	.099	-0.03	.940	0.53	.324	0.46	.305
American Indian, Alaska Native, Other	2.35	.005	1.76	.005	0.19	.826	0.29	.653	2.87	.006	1.32	.088
I prefer not to	-0.21	.736	-0.35	.424	0.09	.892	-0.82	.068	-0.79	.317	-0.68	.215

respond to race

Table 7 continued. Relationships between Undergraduate Research at MSIs and Student Engagement

Social fraternity/sorority member	3.42	.000	2.60	.000	0.61	.272	1.25	.000	1.53	.022	1.53	.000
Living on campus	1.71	.000	0.25	.445	-1.90	.000	-1.60	.000	-0.58	.087	-1.51	.000
Taking all courses online	-11.93	.000	-11.27	.000	1.43	.020	0.53	.127	1.21	.100	2.00	.000
Private institution	0.52	.062	0.01	.974	0.65	.024	0.90	.000	-0.29	.404	1.27	.000
Doctorate-granting institution	0.21	.592	0.06	.855	-0.89	.030	-0.47	.134	-0.61	.214	0.02	.960
Master's-granting institution	-0.45	.164	0.32	.214	-0.27	.422	-0.07	.792	-0.49	.218	-0.06	.853

Note: Reference groups are some college or bachelor's degree aspirations, mostly C grades, White, and Bachelor's-granting Carnegie classification.

Discussion and Implications

Despite the prevalence of UR in higher education (Blanton, 2008) and the demonstrated benefits, particularly for traditionally underserved students (Finley & McNair, 2013; Kinzie et al., 2008), findings herein show that patterns of lower participation for first-generation and Latino(a) students still persist at both PWIs and MSIs. Participation rates for Black students are lower at PWIs, but are on par with the rate of participation for White students at MSIs. This finding supports research by Eagan et al. (2011) which suggests that increased contact between undergraduates and faculty members, and fewer graduate students to work on research, may indicate a campus milieu that encourages research contributes to student participation in UR at MSIs.

> "It is encouraging that Black, Latino(a), Native American, and first-generation students participate at a similar or higher rate as White and Asian students during their first year in college across PWIs and MSIs."

The mixed findings with higher first-year participation and greater equity in Black student engagement in UR but lower participation of other URM students and first-generation students at MSIs suggest that more work is needed at these institutions as well as at PWIs to increase access to research for first-generation and URM students. These findings are consistent with previous research suggesting that URM and first-generation students are less likely to participate in high-impact practices (Finley & McNair, 2013). Our findings also point to the continued need to help high school students learn more about, preparing for, and considering how participation in select activities can contribute to success. This is particularly true for URM and first generation students who may not have parents or other close family members with deep knowledge about the college experience. We know that students with greater confidence and self-efficacy have increased academic performance and adjustment (e.g., Chemmers, Hu & Garcia, 2001; Multon, Brown & Lent, 1991; Zimmerman, Bandura, & Matinis-Pons, 2003), and participation in UR can be a relevant and valued contributor to student success. It is also noteworthy that we did not find evidence that participation in UR hampers participation in other extracurricular activities such as greek social groups or on-campus employment. Perhaps there is a positive effect in that engagement in multiple tasks requires time management and focus.

Previous research has suggested that students gain more from the research experience if they begin within the first two years of college and/or if they participate in research for longer periods of time (Bauer & Bennett, 2003; Hurtado et al., 2008; Jones et al., 2010). It is encouraging that Black, Latino(a), Native American, and first-generation students participate at a similar or higher rate as White and Asian students during their first year in college across PWIs and MSIs. Though these students appear to benefit from early engagement in UR, further research is needed to explore why these higher rates of participation do not persist as students advance through college and, in fact, reverse with lower rates of participation for URM students across institution type by their senior year.

In examining what factors are associated with whether students have participated in research by their senior year at MSIs, we find that factors traditionally associated with privilege are also related to engaging in research with faculty. Students with high academic performance, who are in a STEM field, and who have high educational aspirations are most likely to participate in research. Latino(a) students and transfer students were less likely to engage in research.

Despite persisting patterns of lower participation in UR for URM, first-generation, working, and transfer students, the students who do participate in UR are generally more academically engaged. At MSIs, students who engaged in research with a faculty member more frequently used good learning strategies, utilized quantitative reasoning more often, and worked collaboratively with peers more frequently. These findings support the need to decrease barriers to participation in UR so that more students can benefit from this high-impact practice.

Programs to Decrease Barriers to UR

Agencies such as the National Science Foundation (NSF) see the value and benefits to UR. For example, in 2013 alone, NSF invested approximately $68 million in about 180 new Site awards and 1,600 new Supplement awards for Research Experiences for Undergraduates (REU) (NSF, 2013). A variety of national, state, and campus programs exist to support students in research and these programs are increasingly focused on participation of first-generation and URM students. This research illustrates the need for such programs to provide support in the form of funding for research opportunities, strengthening mentoring relationships, and building connections between students at community colleges and four-year institutions.

The relationship between working during college and participating in research along with the lower participation rates for first-generation and URM students illustrate the importance of funding for research opportunities. In order to allow more students, particularly low-income students, to benefit from research opportunities, paid research opportunities are needed where students can engage in research without sacrificing time spent working to support themselves or their families. Positively, the Department of Education provides funding for URM, first-generation, and low-income students through the McNair Scholars program. This Federal TRIO program awards grants to institutions to provide research opportunities for traditionally disadvantaged students in order to better prepare them for graduate school. Though many funding sources for students to participate in research are limited to STEM fields and our research illustrates that students in STEM are more likely to engage in research, the McNair Scholars program is one of the limited programs that support students across disciplines. As Kuh (2013) points out, UR is a high-impact practice which benefits students in all majors. Further work is needed to engage students both in and outside of STEM in funded research opportunities.

Support from campus programs and intentional mentoring are also important aspects of promoting participation in research for traditionally underrepresented students. As previous research has illustrated, building connections with faculty and other institutional agents is an essential part of retaining traditionally underrepresented students (Cejda & Rhodes, 2004). The McNair Scholars

program pairs students with a faculty mentor who can work with students throughout their research experience and the transition to graduate school. In addition, some campuses are developing support programs for students in research to help them get the most out of their experience. For example the Undergraduate Research Opportunity Center at California State University, Monterey Bay, a Hispanic Serving Institution, uses a two year, cohort model to help students build a network of academically engaged students, build close relationships with their faculty mentors, and get prolonged research experiences. This cohort model also includes a four-part research seminar series where students take one class together each semester to help them build community, make the most out of their research experience and prepare them for graduate education.

In addition to the barriers that first-generation and URM students face, students who transfer from one institution to another have little time to connect to faculty and research opportunities before graduation. University officials must actively reach out to include transfer students in UR. These research opportunities could also function to connect transfer students to their new campus community and faculty. Programs like the Hispanic Serving Institution (HSI), STEM Articulation Grant at California State University, Monterey Bay (U. S. Department of Education, 2011) facilitate partnerships between community colleges and four-year institutions to engage students in research before and after they transfer. This program and similar programs throughout the California State University system allow students to participate in research at the university before they actually transfer in order to use the research opportunity as a bridge between institutions. The NSF funded REU programs also allow for funding of community college students to engage in research at four-year institutions.

Conclusion

This research provides encouraging findings about the benefits of UR at MSIs, early participation in research, and increased rates of participation for Black students at MSIs but also points to areas that need improvement. First-generation, Latino(a), working, and transfer students are still less engaged in research even at MSIs. Despite this, students who did engage in research at MSIs used more of select learning strategies, worked collaboratively with peers more often, and were exposed to more quantitative reasoning experiences. The benefits of UR are clear. As educators and administrators, it is our responsibility to ensure that students have equal access to these opportunities.

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