2015

Undergraduate Research: An Essential Piece for Underrepresented Students' College Success

Yuleinys A. Castillo
Stephen F Austin State University, yuchas@aim.com

Antonio Estudillo
Monmouth University

PURM
Perspectives on Undergraduate Research and Mentoring

Undergraduate Research: An Essential Piece for Underrepresented Students' College Success

Yuleinys A. Castillo, Ph.D., Stephen F. Austin State University, US, castilloya@sfasu.edu
Antonio G. Estudillo, Ph.D., Monmouth University, US

Undergraduate research continues to gain popularity and receive support from universities across the United States (Webber, Laird & BrckaLorenz, 2012). Its significance and value are recognized and accepted, as many studies have focused on the positive aspects of participation and involvement in this educational activity (Buckley, Korkmaz & Kud, 2008; Komarraju, Musulkin, Bhattachary, 2010; Lopatto, 2010). The integrative and mentoring aspects of undergraduate research can help to increase the academic and social integration of underrepresented students (Nagda, Gregerman, Jonides, von Hippel, & Lerner. 1998). Underrepresented students refers to racial and ethnic populations that are disproportionately enrolled in higher education institutions (John & Stage, 2014). National enrollment of underrepresented undergraduate students is at an all-time high, yet there is a persistent disparity for college completion, most notably among the two largest ethnic groups in the United States: Hispanic/Latino/as and African American/Blacks. Among the most recently enrolled students in higher education, the annual rates of actual degree completion varies considerably: Roughly only 9% of Latina/o students earn degrees compared to 10% of African-American students versus well over 65% of European-American students (NCES, 2013). These enrollment and degree completion disparities for minority students present an underlying narrative for institutions of higher education and the specific need to identify and implement concentrated means of recruiting and retaining underrepresented ethnic minority students.

The Council for Undergraduate Research (CUR), a national institution of colleges, universities and individuals of over 900 members, supports and promotes student and faculty collaboration in undergraduate research. Moreover, CUR is committed to inclusivity and diversity and seeks to increase participation of underrepresented individuals and groups in undergraduate research. Opportunities to participate in undergraduate research exist in many institutions but understanding students' perceived benefits and perceptions of potential barriers (Adedokun & Burgess, 2011) as well as faculty support of students' research activities and institutional investments (Zydney, Bennett, Shahid, & Bauer, 2002) can help institutions promote inclusion and diversity in undergraduate research activities.

Undergraduate research presents opportunities for increased involvement in college activities and the development of personal and professional skills for underrepresented students (Lopatto, 2009). To foster increased participation of historically underrepresented ethnic minority students, the institutional investment in undergraduate research ought to consider these areas: the link between their missions regarding undergraduate research and positive student learning outcomes (e.g., receiving well-rounded educational experiences; emphasis on student retention); support for faculty who involve students in research pursuits (e.g., internal funding; celebrating and rewarding diverse research agendas); and the availability of opportunities to facilitate faculty-mentor and student-

mentee research collaborations (Arum, Rosksa, & Cho, 2011; Hordern, 2013; Hunter, Laursen, & Seymour, 2007). Increasing the participation of underrepresented students in undergraduate research and the consideration of best practices for supporting college success may require that these two areas be reevaluated simultaneously by institutions. Supporting minority students who participate in research not only pushes knowledge forward, but also provides considerable access to opportunities for career exploration and experiential learning for these students (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011).

As the representation of underrepresented students at the undergraduate level continues to increase for colleges and universities, identifying methods to overcome racial disparities in education becomes crucial information for institutions (Farkas, 2003). Underrepresented minority students appear to be more sensitive to the social and cultural factors associated with retention such as academic confidence, positive faculty-student relationships, access to role models or mentors, and involvement in campus activities (Fischer, 2007). Students who are marginalized in higher education often struggle with self-doubt and a lack of academic self-efficacy (Rice, Lopez, Richardson & Stinson, 2013). Undergraduate research represents an academic activity that can improve retention and degree completion among underrepresented students (Jones, Barlow & Villarejo, 2010) while improving the overall college experience for these students. In this literature review, the benefits and perceived challenges for underrepresented students as well as institutional investment in undergraduate research are explored in hopes of increasing college success for historically marginalized college students. In addition, some recommendations are presented for individuals and institutions interested in undergraduate research.

Benefits of Undergraduate Research

"Participation in undergraduate research represents an opportunity for underrepresented students to enhance work related skills that can better prepare them for their future careers and interpersonal relationships."

Impact on Students' College Involvement

Involvement in undergraduate research has been found to create positive effects in students' college learning experiences (Jones, Barlow & Villarejo, 2010). When engaging in undergraduate research, students benefit in different areas such as skills acquisition, professional and personal development, responsibility, knowledge synthesis, and professional advancement (Lopatto, 2009). Specifically, students reported betterment of many types of skills including interaction and communication, data collection and interpretation, research design and hypothesis testing, information literacy, and computer skills. Moreover, students can learn to understand and implement the scientific method, develop fundamental research skills, and work collaboratively with others (Grossman, Patel & Drinkwater, 2010). Participation in undergraduate research represents an opportunity for underrepresented students to enhance work-related skills that can better prepare them for their future careers and interpersonal relationships.

Students from different fields of study have expressed how undergraduate research contributed to their mastery of a variety of skills. In a national study that examined the effect of disciplines on student perceptions of the undergraduate research experience, most students in the Humanities, Business, and Education majors reported that they improved their ability to synthesize and organize information (Buckley, Korkmaz & Kud, 2008). Additionally, the Science and Social Science majors expressed that they increased their understanding of research while engineering majors gained critical thinking and data analysis skills. As a result, undergraduate research provides an opportunity for development for students in a variety of areas at the personal and professional levels. Regardless

of the major, disadvantaged students can learn useful skills in college that can translate not only to the work environment but also to general personal development.

Undergraduate research can also enhance the students' experiences in college as they participate in engaged learning. In a quantitative study of 2,444 alumni of the University of Delaware, Bauer and Bennett (2003) asked alumni about their participation in undergraduate research programs. They found that participation increased their exposure to hands-on learning experiences that helped in developing cognitive and personal skills, academic involvement, and interest in graduate school. By participating in undergraduate research, students developed a sense of contribution to and understanding of their field, enriched their proficiency in techniques and skills relevant to their discipline, and identified potential career paths (Lopatto, 2010; Sabatini, 1997). Increasing students' involvement, interest, and contribution to their field and career can help with personal growth, self-discovery, and confidence (Lopatto, 2009).

In addition, undergraduate research can help students to create a positive view and pursue different options for their education. In an earlier study performed at four liberal arts colleges, students and faculty advisors who worked collaboratively on research projects were interviewed about their participation in undergraduate research (Hunter, Laursen, & Seymour, 2007). From these interviews, the authors reported that students' negative perceptions of the sciences were diminished by engaging in undergraduate research. This experience provided opportunities for students to network and find support from faculty, peers, and science professionals. Specifically, the research activities provided a mechanism to develop academic and practical skills that solidified the students' identities as future scientists.

As underrepresented students develop a sense of belonging within their fields and future careers they may begin to feel more motivated and invested in their academic disciplines. They may want to complete their educational goals which will improve retention and graduation rates among this group. Moreover, undergraduate research programs have been effective at retaining students within STEM (Science Technology Engineering and Mathematics) disciplines and have increased underrepresented students from different racial and socioeconomic groups in these majors (Adedokum & Burgess, 2011). Likewise, underrepresented ethnic students were more likely to earn a science or engineering bachelor's degree and enroll in graduate education when participating in scientific research projects as early as possible during their undergraduate experience (Summers & Hrabowski, 2006). Undergraduate research presents a way to retain students with interest in science and engineering and this will later increase the numbers in the workforce in these areas. Introducing underrepresented minority students to undergraduate research early on in their education and for an extended period of time helps to reduce attrition rates from science majors and helps to improve performance for these students (Jones, Barlow & Villarejo, 2010).

The involvement in academic activities, like undergraduate research, can also help with the integration of students in college. Students expressed that they feel they belong to a learning community by establishing relationships with mentors and peers during their undergraduate research experience (Lopatto, 2010). Students have also reported an increased interest in graduate school after participating in research as an undergraduate (Zydney et al., 2002). Undergraduate research can become an effective method to recruit students to graduate programs, even for students from minority backgrounds. In one study, minority students who participated in undergraduate research were more likely to be currently enrolled in, have graduated from or were planning to enroll in, a graduate program in comparison to minority students without undergraduate research experience (Morley, Havick & May, 1998). Introducing undergraduate research early on and for an extended period of time appears to improve retention and performance among minority students (Jones, Barlow & Villarejo, 2010). In addition, it also increases their commitment to

completing their bachelors' degrees and prompts them to consider graduate school.

Value of Faculty-Mentor Collaborations

Undergraduate research generates benefits for those students participating in this form of engaged learning, but faculty members also attain professional and personal benefits. Students expressed a preconception that they would receive extensive mentoring and supervision from faculty mentors as an essential component of their research learning experience (Adedokum & Burgess, 2011). Faculty members who actively engage in undergraduate research activities gain knowledge, become mentors, and contribute to their research agenda. The student-faculty interaction helps to increase academic achievement and educational aspirations among students (Cole, 2007), especially for Latino/a and African American students who were involved in research and mentorship activities with faculty (Cole & Espinoza, 2008). Moreover, Toldson and Esters (2012) found that high-achieving minority males in STEM disciplines benefit from faculty engagement, involvement in undergraduate research, and financial support. Having continuous interaction with students and other faculty members can create a sense of community and support improving academic outcomes and interpersonal relationships. Underrepresented students who value positive formal academic relationships, create informal social ties with peers, and who are involved in college activities tend to adjust more easily to the college environment; These students are also more likely to complete their degrees (Fischer, 2007).

Undergraduate research represents an opportunity for faculty to produce new knowledge while fulfilling the research expectations of an academic appointment. Undergraduate research mentoring can help to improve the integration of research and teaching while enhancing undergraduate education (Lopatto, 2009). In a previous study by Salsman, Dulaney, Chinta, Zascavage, and Joshi (2013), student and faculty mentor involvement and the time invested in the undergraduate research project were both found to have a positive influence on the research experience. Moreover, the hours worked on the research project were found to have a positive correlation with the perceived benefits by students while the time spent on the research project by the research mentor/faculty had a positive impact on student effort. Faculty collaborations across departments involving undergraduate research generated an opportunity to increase multidisciplinary research and to solidify relationships across departments. The dedication and commitment from the faculty mentor can help to create a positive learning experience and improve degree completion for those students participating in undergraduate research (Cole, 2007).

Participation in undergraduate research can foster academic collaboration, with regular faculty contact, and a positive peer advising environment (O'Donnell, Botelho, Brown, González, & Head, 2015). Student-faculty interactions are positively associated with student learning, academic engagement, and a positive campus experience (Kuh & Hu, 2001). Increasing underrepresented students' participation in undergraduate research can help to enhance their college experience. For example, Wilson et al. (2011) explained that the Howard Hughes Medical Institute (HHMI) Professors Program at Louisiana State University uses a mentoring model to address STEM student attrition at the undergraduate level. The model incorporates mentoring, research, and education, resulting in greater retention and STEM graduation rates for all participants but particularly from underrepresented students. In the HHMI program, students received a complete assessment of learning styles, challenging research opportunities, interactions with mentors, and support. The structure of the innovative LSU HHMI research program has helped students to excel in their programs of study by providing mentoring, research opportunities, peer interactions, and academic support services.

Research has also found that faculty from minority backgrounds are more likely to participate in and perceive undergraduate research activities as important for academic success (Webber, Laird &

BrckaLorenz, 2012). Faculty members can also help in students' acclimation to college by working in research activities and establishing mentoring relationships with students (Cole, 2007). Faculty from minority backgrounds can also help to increase participation rates and become a role model for undergraduate students. According to Hurtado, Eagan, Tran, Newman, Chang and Velasco, minority students reported that it was easier for them to identify faculty mentors and same-race role models (2011). However, institutions may disproportionately rely on minority faculty to involve students in research activities without adapting their formalized programs and supports. Thus, the institutional culture may play a role in emphasizing and recognizing engagement in research and other academic activities for students from underrepresented groups.

Undergraduate research can also lead to potential collaborations between community partners and academics. A relative new mode of inquiry is community-based research which is defined as a collaborative research relationship between students, faculty, and community members intending to solve a prevalent community problem or generate social change (Strand, Marullo, Cutforth, Stoecker, & Donohue, 2003). This activity can increase the involvement and participation of academics in their communities while making a local impact that benefits all parties involved. For underrepresented students, community-based research can expose them to community issues, establish career networks, and foster student interest in social change (Lopatto, 2010). At the same time, students can help address social issues that affect them and even their families directly, becoming active figures of social change.

Undergraduate research provides students with academic engagement, knowledge production, critical evaluation, and improvement of personal and professional capabilities (Brew, 2013). The opportunity to learn and master new skills in intervention programs, including undergraduate research, for underrepresented students provides positive outcomes and an increased interest in science-related careers (Summers & Hrabowski, 2006). Even though underrepresented students can learn a variety of skills from undergraduate research, there are challenges and barriers that may impact their intentions to participate in these research programs.

"Undergraduate research represents an opportunity for faculty members to establish mentoring and collaborative relationships with students while providing a different teaching experience."

Perceived Challenges to Engaging in Undergraduate Research

Even though undergraduate research offers a variety of positive academic outcomes for students, there are some barriers that may affect students' participation. Adedokum and Burgess (2011) analyzed students' opinions to help educators understand their preconceptions about research activities and relationships. Before getting involved in research, students expected that they would receive extensive mentoring and supervision from their faculty mentors. However, they later learned that graduate and postdoctoral mentors were mainly responsible for the research progress and outcome (Adedokum & Burgess, 2011). Even though students in this study had a positive experience with their mentors in their research activities, they mentioned that they had expected more interaction and work with the faculty mentor. Additionally, some faculty members may be hesitant to participate in undergraduate research because it can be more time consuming than working with graduate students. However, some faculty members think that undergraduate students receive significant educational and professional benefits including intellectual curiosity, logical thinking, and processing the information from the research experience (Zydney et al., 2002).

Undergraduate research represents an opportunity for faculty members to establish mentoring and

collaborative relationships with students while providing a different teaching experience. Faculty who are willing to engage in undergraduate research can help to successfully promote research opportunities among students (Zydney et al., 2002). Even though some students may be interested in participating in undergraduate research so they can learn about their discipline or gain research skills, the limited number opportunities to experience research activity (Healey & Jenkins, 2009) at the university and faculty levels can discourage potentially interested participants. In a program evaluation of a midsized psychology department who wanted to increase undergraduate students' access to research experiences, five barriers were identified: lack of student awareness; unequal student access; poor curricular timing; lack of publicity; and irregular incentives for faculty (Wayment & Dickson, 2008). After implementing five changes – application procedures, advertisement, communication with majors, creation of a newsletter, and restructured faculty teaching assignments, this psychology department experienced an increase of over 30% student involvement in undergraduate research. These findings suggest that informing students about research opportunities, increasing recruitment efforts, and providing incentives for faculty can help increase students' participation in research. Many universities also lack a formal program that offers and encourages undergraduate research opportunities for students and faculty (Lopatto, 2009). Universities' commitment to research activities, including funding and programs, can help to increase research activities among faculty and students.

Understanding students' intentions behind their decision to participate in undergraduate research can also help faculty and universities identify ways to increase their participation in this academic activity. In a previous study that conducted latent profile analyses on 1,052 undergraduate students from three universities, students who expressed that intrinsic and extrinsic motivators were important to them tended to be drawn towards science careers and research activities (Smith, Deemer, Thoman & Zazworsky, 2014). A student who is intrinsically motivated may want to pursue research for the satisfaction derived from an intellectual challenge, the scientific process itself, or the discovery of new information. In the same way, a student with extrinsic motivation who may desire high academic recognition, admission into graduate school, or a potential research publication may use undergraduate research as a tool to meet personal and professional needs. Another finding from this study suggested that women were found to be as likely as men to show extrinsic and intrinsic interest in research; however, women were more likely to be perceived as unmotivated by faculty members. Other studies have shown that underrepresented minority women are just as likely as their white female counterparts to show interest in STEM degrees (Nassar-McMillan, Wyer, Oliver-Hoyo & Schneider, 2011; Smyth, & McArdle, 2004). To reduce minority women's attrition from STEM fields, institutions can improve these students' college experiences by including enrichment programs (such as undergraduate research) and identifying influential role models for these women (Ong, Wright, Espinosa & Orfield, 2011). These are valuable things to consider when coordinating academic activities because women have also reported lower participation in undergraduate research than men in a previous study (Webber, Laird & BrckaLorenz, 2012).

Exploring and understanding students' expectations and potential challenges for participating in undergraduate research can help to increase the participation of underrepresented students while showing them that faculty, advisors, and staff care about their education and success. Specifically, undergraduate research programs targeting underrepresented students can help to improve retention and graduation rates by fostering a sense of belonging and community among students (Jones, Barlow & Villarejo, 2010). The investment and commitment to undergraduate research by colleges and universities can help to diversify not only the student population but the workforce as well (Ong, Wright, Espinosa & Orfield, 2011).

Institutional Role in Supporting Undergraduate Research

Undergraduate student participation in undergraduate research, particularly in relation to underrepresented student populations, serves as a primary basis for efforts to recruit and retain students from diverse backgrounds. Students can have access to a wide range of educational experiences that lead to well-rounded opportunities for personalized learning and growth. Researchers suggest that undergraduate research helps students to gain confidence in their academic abilities, which leads to greater persistence and academic achievement for all students in general and for underrepresented students as well (Jones, Barlow & Villarejo, 2010). For example, research in the STEM fields has highlighted this positive impact of undergraduate research on underrepresented student population performance (Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013). Institutional investments in undergraduate research plays a major role in innovative approaches supporting student learning outcomes, student retention, and degree attainment. Equally, it creates a direct outcome of strengthening the quality of education for students.

The ways in which the benefits of student participation in undergraduate research get communicated to interested students may require sound evaluation and discussion. Berkes (2008) suggested that students engaged in undergraduate research typically fall under the category of either being faculty nominated or self-initiated. Therefore, the widening of undergraduate research participation, especially in relation to underrepresented students, may speak to identifying students who have already been identified as high-achieving or who have the potential for being high-achieving. Among STEM majors, when underrepresented students do participate in undergraduate research it is likely that these students have already maintained a high grade point average (Russell, Hancock & McCullough, 2007). This underscores a level of individual student-planning taking place that contributes to eventual involvement in undergraduate research. For institutions to be successful in increasing their undergraduate research participation, well thought-out opportunities must be presented to students early through various spaces and activities. Pike and Kuh (2005) explain that a quality higher educational experience refers to opportunities for students to access a wide range of diverse educational experiences—the quality of which depend upon how institutions invest in policies and practices.

Some institutions have purposefully developed and established offices of undergraduate research. These offices help to create awareness of undergraduate research. In addition, they also support connections between faculty offering research opportunities and departments who showcase programs that inform students of particular fields of study (Berkes, 2008). Two strong undergraduate research councils that oversee system-wide undergraduate research programming include the University of Wisconsin (UW), historically serving traditional undergraduate student enrollment (Galen, Schneider-Rebozo, Havholm, & Andrews, 2015) and the City University of New York (CUNY) which focuses more on serving a urban student enrollment (MacLachlan & Caplan, 2015). At the UW, for example, undergraduate research gets pursued and encouraged and the offices help to facilitate faculty-led projects. As a result, undergraduate research helps to foster student retention, increases student graduation rates, and contributes to the community-economy by preparing workforce-ready students. In the CUNY system, the areas that undergraduate research oversight has impacted are in strategic planning and funding. Here, grant money has been offered to faculty to initiate projects with their students and stipends have been given to support individual students who engage in projects with their faculty. These practices support the quality of educational experiences that students receive and may positively impact students by reinforcing both student research interests and by encouraging faculty and student collaborations. For example, research on the educational experiences of students in higher education suggests that opportunities for students to engage faculty, both formally and informally, contributes to positive student academic socialization (Komarraju, Musulkin, Bhattachary, 2010). In particular, institutions that formalize undergraduate research programs are supporting hands-on learning among students and are contributing to

students' exposure to an inclusive educational experience.

Snow, DeCosmo, and Shokair (2010) have highlighted a variety of institutional investments in undergraduate research that can target larger pools of students. These investments include the development of campus-wide undergraduate research offices aimed at broadening student interest in respective fields, the sponsorship of internal or individual academic unit symposia facilitating beyond-the-classroom knowledge and expression, the development of summer research institutes for students that lead into developing independent research projects, and organizational databases that can highlight broad research opportunities with outside universities (that may offer more options for students to pursue). To further expand upon these areas, incentives for underrepresented students can be embedded in the form of spotlighting specific projects, themes, and research agendas that attend to the interests, ambitions, and inspirations of a diverse segment of students (e.g., community-based research). Universities can scale these types of practices to target underrepresented students. Those institutions that develop clearer missions to do just this also tend to have a clear understanding of diverse faculty's research and teaching. They also tend to prioritize institutional efforts that enhance the overall student learning experience (Arum, Roksa, & Cho, 2011).

The institutional investment placed on undergraduate research has the potential to contribute to student learning and reinforce positive outcomes for students, especially degree completion (Lopatto, 2007). Most research on the impact of institutional investments on undergraduate research centers on how institutions of higher education can foster an institutional climate that values collaborative research experiences between faculty and students. Institutional investments in undergraduate research programming that contribute to the educational climate ought to reflect the positive educational identities that students can develop over time. A major component for institutions may be spotlighting undergraduate research. This signals a commitment to students' personal and academic socialization while simultaneously allowing for faculty to model high impact practices. These types of messages support all students and underrepresented students in particular. Students who gain direct access to faculty expertise may be more likely to become well-connected to their educational surroundings (O'Donnell et al., 2015).

A potential point of uncertainty is that even institutions with concentrated research missions do not always lead to students taking full advantage of undergraduate research (Hu, Kuh, & Gayles, 2007). This is likely in part because some institutions continue to struggle with finding a balance between investments in research, teaching, or both and what this actually means for faculty and student recruitment and retention (Prince, Felder, & Brent, 2007). A challenge for institutional investment in undergraduate research - regardless of whether it is a research intensive or teaching-oriented institution - is whether or not investment in undergraduate programming contributes to positive student learning outcomes such as gains to student's actual academic ability and applied knowledge.

Faculty in specialized research areas can enhance the quality of undergraduate research experienced by students. The sciences serve as a signature field that attempts to develop these ideals, as many faculty members oversee laboratories with the expectation that faculty will guide and facilitate hands-on-learning experiences among students. This direct faculty-to-student engagement speaks to opportunities for apprenticeship and the furthering of student's academic and professional development (Hunter, Laursen, & Seymour, 2007). All of these experiences contribute immensely to student learning and retention. This suggests that institutions seeking to support their undergraduate research programs ought to also invest in faculty development. Hordern (2013) suggested, for example, that institutions should prioritize research and teaching and student learning through institutional investments in quality institutional management, academic staffing,

and support as well as advanced postgraduate student support and university funding.

The success of undergraduate research activities among underrepresented students and for student learning in general is based on how well institutions can articulate and implement university policies that generate teaching and research opportunities. These policies can include developing faculty expertise through opportunities for funding, laboratory space, or incentives. Using undergraduate research to engage underrepresented students can help to improve how faculty approach teaching and learning as well as the students' own college experience. Further, undergraduate research can help students to develop and improve their social and academic skills (Osborn & Karukstis, 2009). Taken together, when institutional investment works so may the development of educational climates where both faculty and students alike can thrive in their respective roles in academia. Reviewing institutional investments in undergraduate research can ultimately lead to a set of recommendations that highlight critical areas where universities can evaluate current policies and practices.

Discussion and Implications

Undergraduate research represents a hands-on learning activity that can enrich the educational experience of underrepresented students by improving developmental and professional skills (Lopatto, 2009), campus experience (Kuh & Hu, 2001), and degree attainment (Adedokum & Burgess, 2011). As the number of underrepresented students' enrollment in college and universities continues to increase in the United States, identifying methods to enhance their college experience can help institutions to improve retention and degree completion among these students.

Effective Use of Undergraduate Research

By participating in undergraduate research, underrepresented students can improve many types of skills such as critical thinking, communication skills, and professional abilities (Bauer & Bennett, 2003; Lopatto, 2009). However, institutions need to increase the awareness of and opportunities for undergraduate research as a learning activity. This can help with student success and interest in graduate education. Increasing involvement in campus activities can help to improve minority retention and educational outcomes as well as to diminish any negative campus perceptions among students (Fischer, 2007). Undergraduate research can help to retain well-prepared minority students in college by providing a motivation, expectation for performance, and a sense of identity. Similarly, the support, mentoring, and monitoring of underrepresented students in undergraduate research can ensure equity and diversity in a variety of disciplines and careers.

Undergraduate research can contribute to a positive social exchange for students and faculty members. Students can develop a sense of belonging to a learning community that shares similar interests and goals. At the same time, students with experience in undergraduate research can become mentors and encourage first and second year students to seek out involvement in research. In particular, introducing students to undergraduate research early on supports the retention and performance of students, especially underrepresented minorities (Jones, Barlow, & Villarejo, 2010). In addition, undergraduate research can help to improve the quality of faculty member work-life perspectives, in turn affecting work satisfaction and faculty turnover (Webber, 2012). Faculty members can also explain to students how to get involved as well as share with them some of the personal and professional benefits associated with undergraduate research. Faculty mentors and students working together can mutually benefit from the experience, both professionally and personally. Therefore, a recommendation for universities is that it is critical to be intentional in promoting undergraduate research. For example, universities should include undergraduate research within their strategic plans as this can contribute to student retention. Students who engage in undergraduate research can receive critical experiences and applied knowledge in their respective career fields.

Development of Research Agendas

As undergraduate research grows in popularity across colleges and universities, understanding its benefits and impact can help institutions offer effective programs and supports. In particular, exploring the experience of underrepresented students who have engaged in undergraduate research can help in understanding a variety of environmental and personal factors that improve the overall college experience, graduation outcomes, and career decisions of these students. Underrepresented students' expectations for research opportunities before, during, and after their involvement in undergraduate research can also provide valuable insight into their motivations, learning, and experience. As minority faculty members are slowly increasing their representation in educational institutions, they can act as role models for undergraduate students interested in research; this can provide valuable information for individuals and institutions. For example, diverse faculty may help ensure that institutions are promoting a wide range of research agendas that in turn may attract interest from a broader student population interested in pursuing undergraduate research.

An underlying consideration for faculty is whether their own area of research is intended to involve students in some capacity—whether in the planning or executing of a project -- versus research that is intended to have students as the audience/consumer. This means that perhaps increasing participation of underrepresented students in undergraduate research may actually begin with whether or not faculty had this particular student population originally in mind. For faculty who are pursuing research and are interested in attracting increased underrepresented student participation, some initial questions to consider are:

- Should I consider underrepresented student populations in the planning and organizing, delivery and execution, or follow-up and evaluation of my research agenda?
- At a practical level, how does my research agenda involve students and what is the added benefit of having diverse student participation?
- In terms of supporting undergraduate research, can I identify students that have the potential to successfully complete an independent project? Specifically, what strategies have I used to encourage underrepresented student participation?
- Does my research agenda align with the interests of the underrepresented student population?

Ultimately, these questions may revolve around the campus climate and institutional messages that are sent to faculty and underrepresented students—such as whether there are personal and professional rewards for engaging in undergraduate research (Hurtado et al., 2011). For example, faculty may be more inclined to develop research agendas directly engaging underrepresented student populations if such practices result in both professional and career recognition. Similarly, students may be more open to engage in undergraduate research if such practices align with culturally centered perspectives, linking their field of study to community promotion and quality enhancement.

Institutional Practices and Considerations

Based on the best practices literature aimed at institutions interested in developing successful undergraduate programs, priorities such as clarifying institutional missions, developing support for faculty, and improving upon the quality of educational experience accessed by students may each have a significant role. In terms of institutional missions, reinforcing classroom knowledge may translate to placing undergraduate research as a direct means to engage in experiential learning. Because individual faculty may not always be trained in how to manage or supervise undergraduate research while simultaneously progressing their own research agendas forward, institutions can

provide training and support to faculty who successfully carry out research. In addition, institutions can help to align faculty research agendas with underrepresented students who are interested in participating in research. For example, the support staff in an institutionalized office of undergraduate research can help identify a pool of students, provide professional development for faculty interested in overseeing undergraduate research projects, and offer advice to faculty interested in high impact practices. These actions are in line with the overarching premise behind undergraduate research in which underrepresented students with faculty support begin to take on advanced ownership of their learning. At the same time, institutions should develop an atmosphere that understands the value of undergraduate research as an engaged learning experience.

Recommendations for Future Research

This paper reviewed undergraduate research and its relation to the quality of education that underrepresented students may receive, but there is need for further research. Questions that need more attention are: How and why do faculty facilitate undergraduate research projects; What are some effective strategies that encourage underrepresented student participation; and what are some clear examples of institutions that have invested in undergraduate research opportunities for marginalized populations? Research centered on faculty perspectives can examine variations in the usage and frequency of undergraduate research programming at both public and private institutions. For example, qualitative research may help to outline and compare the timing, challenges, and successes faculty experience in linking undergraduate research to the retention of underrepresented students. In addition, research on the faculty experience on how overseeing undergraduate research projects may or may not support tenure status is needed. Finally, research on whether faculty receive support from institutions through funding or other means to engage in such practices is also warranted.

Research on institutional practices can examine the links between institutional missions and the quality of their experiential learning activities. We should consider how and when institutions develop and execute opportunities to recruit and retain underrepresented students in undergraduate research. Specifically, do institutions focus on certain areas of study when considering underrepresented undergraduate researchers and are such undergraduate research programs found system-wide? Institutional research is also critical when it comes to understanding how decisions are filtered throughout the institution to individual colleges, schools, departments, and eventually to faculty and students. One could study how institutions formally support faculty and students in undergraduate research through funding, project consultation and development, and focused attention on supporting underrepresented students.

The effectiveness of engaging in undergraduate research and students' commitment levels for those who self-elect to pursue versus those who are asked to engage in research also can be explored. For example, are there distinctions in commitment levels, skill development, and degree completion among different types of underrepresented students who participate in undergraduate research? Lastly, we also have questions surrounding the best strategies for the recruitment and retention of underrepresented students in undergraduate research. Future research can lead to up-to-date information that can help to inform and develop policies; these policies in turn may help create the conditions for successful undergraduate research programming.

References

Adedokun, O. A. & Burgess, W. D. (2011). Uncovering student preconceptions of undergraduate research experiences. *Journal of STEM Education*, *12*(5), 12–22.

Arum, R., Roksa, J., & Cho, E.. (2011). Improving undergraduate learning: Findings and policy recommendations from the SSRC-CLA longitudinal project.

Brooklyn, NY: Social Science Research Council.

Bauer, K. W. & Bennett, J. S. (2003). Alumni perceptions used to assess undergraduate research experience. *The Journal of Higher Education, 74*, 210–230.

Berkes, E. (2008). Undergraduate research participation at the university of California, Berkeley. Center for Studies in Higher Education. Berkeley, CA.

Brew, A. (2013). Understanding the scope of undergraduate research: A framework for curricular and pedagogical decision-making. *Higher Education, 66(*5), 603-618.

Buckley, J. B., Korkmaz, A., & Kuh, G. (2008). *The disciplinary effects of undergraduate research experience with faculty on select student self-reported gains*. Paper presented at the Association for the Study of Higher Education conference, Jacksonville, FL.

Cole, D. (2007). Do interracial interactions matter? An examination of student-faculty contact and intellectual self-concept. *Journal of Higher Education, 78*(3), 248–272.

Cole, D. & Espinoza, A. (2008). Examining the academic success of Latino students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Student Development, 49*(4), 285–300.

Farkas, G. (2003). Racial disparities and discrimination in education: What do we know, how Do we know it, and what do we need to know? *Teachers College Record, 105*(6), 1119-1146. doi:10.1111/1467-9620.00279

Fischer, M. J. (2007). Settling into campus life: Differences by race/ethnicity in college involvement and outcomes. *The Journal of Higher Education, 78*, 125–161.

Galen, D. V., Schneider-Rebozo, L., Havholm, K., & Andrews, K. (2015). Undergraduate research and economic development: A systems approach in Wisconsin. *New Directions for Higher Education, 169,* 39–49.

Grossman, J., Patel, M., & Drinkwater, L. (2010). Enhancing undergraduate agro-ecological laboratory employment through experiential learning. *Journal of Natural Resources & Life Sciences Education, 39*(1), 39: 31–39.

Hernandez, P. R., Schultz, W., Estrada, M., Woodcock, A., & Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology, 105*(1), 89-107.

Hordern, J. (2013). Undergraduates and research: Connectivity in the university. *Educational Studies, 39 (5)*, 535-547.

Hu, S., Kuh, G. D., & Gayles, J. G. (2007). Engaging undergraduate students in research activities: Are research universities doing a better job? *Innovative Higher Education, 32*, 167–177.

Hunter, A-B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*(1), 36–74.

Hurtado, S., Eagan, K. M., Tran, M. C., Newman, C. B., Chang, M. J., & Velasco, P. (2011). We do science here: Underrepresented students' interactions with faculty in different college contexts. *Journal of Social Issues, 67*(3), 553-579.

Jenkins, A. & Healey, M. (2009). Developing the student as a researcher through the curriculum. In C. Rust (Ed.), *Improving Student Learning through the Curriculum.* Oxford Brookes University, Oxford: Oxford Centre for Staff and Learning Development.

John, G. & Stage, F.. (2014). Minority-Serving Instutions and the education of U.S. underrepresented students. *New Directions for Institutional Research, 2013*(158), 65-76.

Jones, M. T., Barlow, A. E., & Villarejo, M. (2010). The importance of undergraduate research for minority persistence and achievement in Biology. *Journal of Higher Education 81*, 82-115.

Komarraju, M., Musulkin, S., & Bhattachary, G. (2010). Role of student-faculty interaction in developing college students' academic self-concept, motivation, and achievement. *Journal of College Student Development, 51*(3), 332-342.

Kuh, G.D., & Hu, S. (2001). The effects of student-faculty interaction in the 1990s. *Review of Higher Education, 24*, 309–32.

Lopatto, D. (2007) Undergraduate research experiences support science career decisions and active learning. *CBE-Life Sciences Education 6*, 297–305.

Lopatto, D. (2009). *Science in Solution: The Impact of Undergraduate Research on Student Learning*. Tucson: The Research Corporation for Science Advancement.

Lopatto, D. (2010). Undergraduate research as a high impact student experience. *Peer Review, 12*(2), 27–30.

MacLachlan, E. S., & Caplan, A., J. (2015). Fostering resources for undergraduate research at the city university of New York. *New Directions for Higher Education*, 169, 73-83.

Morley, R. L., Havick, J. J., & May, G. S. (1998). An evaluation of the Georgia Tech summer undergraduate program of research in electrical engineering for minorities. *Journal of Engineering Education*, July, 321–325.

Nagda, B. A., Gregerman, S. R., Jonides, J., von Hippel, W., & Lerner, J. S. (1998). Undergraduate student-faculty research partnerships affect student retention. *Review of Higher Education, 22*(1), 55–72.

Nassar-McMillan, S., Wyer, M., Oliver-Hoyo, M., & Schneider, J. (2011). New tools for examining undergraduate students' STEM stereotypes: Implications for women and other underrepresented groups. *New Directions for Institutional Research, 2011*(152), 87–98.

O'Donnell, K., Botelho, J., Brown, J., González, G., & Head, W. (2015). Undergraduate research and its impact on student success for underrepresented students. *New Directions for Higher Education, 169*, 27–38.

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review, 81*(2), 172–209.

Osborn, J. M. & Karukstis, K. K. (2009). The benefits of undergraduate research, scholarship, and creative activity. In M. Boyd and J. Wesemann (Eds.) *Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact*. (pp 41-53). Council on Undergraduate Research, Washington, DC.

Pike, G. R., & Kuh, G. D. (2005). A typology of student engagement for American colleges and universities. *Research in Higher Education*, 46, 185–210.

Prince, M. J., Felder, Richard M., & Brent, R. (2007). Does faculty research improve undergraduate teaching? An analysis of existing and potential synergies. *Journal of Engineering Education*. 96, 283-294.

Rice, K., Lopez, F., Richardson, C., & Stinson, J. (2013). Perfectionism moderates stereotype threat effects on STEM majors' academic performances. *Journal of Counseling Psychology, 60*(2), 287–293.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science, 316*, 548–549.

Sabatini, D. A. (1997). Teaching and research synergism: The undergraduate research experience. *Journal of Professional Issues in Engineering Education and Practice, 123*, 98–102.

Salsman, N., Dulaney, C. L., Chinta, R., Zascavage, V., & Joshi, H. (2013). Student effort in and perceived benefits from undergraduate research. *College Student Journal, 47*(1), 202.

Smith, J. L., Deemer, E. D., Thoman, D. B., & Zazworsky, L. (2014). Motivation under the microscope: Understanding undergraduate science students' multiple motivations for research. *Motivation and Emotion, 38*, 496-512.

Smyth, F. L. & McArdle, J. J. (2004). Ethnic and gender differences in science graduation at selective colleges with implications for admission policy and college choice. *Research in Higher Education, 45*(4), 353–381.

Snow, A. A., DeCosmo, J., & Shokair, S. M. (2010). Low-cost strategies for promoting undergraduate research at research universities. *Peer Review*, 16-19.

Strand, K., Marullo, S., Cutforth, N., Stoecker, R., & Donohue, P. (2003). *Community-based research in higher education: Methods, models and practice*. San Francisco, CA: Jossey-Bass.

Summers, M. F. & Hrabowski III, F. A. (2006). Preparing minority scientists and engineers. *Science, 311*(5769), 1870–1871.

Toldson, I. A., & Esters, L. L. (2012). *The quest for excellence: Supporting the academic success of minority males in science, technology, engineering, and mathematics (STEM) disciplines*. Washington, DC: Association of Public and Land-grant Universities.

U.S. Department of Education, National Center for Education Statistics. (2013). Digest of Education Statistics, 2010.

Wayment, H., & Dickson, K. L. (2008). Increasing student participation in undergraduate research benefits students, faculty, and department. *Teaching of Psychology, 35*, 194–197.

Webber, K., Nelson Laird, T.F., & BrckaLorenz, A. (June 4, 2012). *Student and faculty member engagement in undergraduate research*. Paper presented at the Association for Institutional Research 2012 Annual Conference. New Orleans, LA.

Wilson, Z, Holmes, L., deGravelles, K., Sylvain, M., Batiste, L., Johnson, M., & Warner, I. (2011). Hierarchical mentoring: A transformative strategy for Improving diversity and retention in undergraduate STEM disciplines. *Journal of Science Education and Technology, 21*(1), 148-156

Zydney, A. L., Bennett, J. S., Shahid, A., & Bauer, K. W. (2002). Faculty perspectives regarding the undergraduate research experience in science and engineering. *Journal of Engineering Education*, July, 291–297.