A scholar-practitioner perspective to promoting minority success in STEM

Megan Covington, Terry Chavis and April Perry
Department of Higher Education Student Affairs, Western Carolina University, Cullowhee, North Carolina, USA

Abstract

Purpose – The purpose of this conceptual paper is to present the existing research on already effective programmatic efforts designed to increase diversity in STEM fields and to subsequently encourage researchers and practitioners to more intentionally build upon and design effective interventions around this issue.

Design/methodology/approach – Previous research findings accredit this success to various forms of support, such as mentors, study groups, student programs and student organizations (Hurtado *et al.*, 2012; Maton *et al.*, 2000; May and Chubin, 2003).

Findings – Higher education professionals have experienced a rise in concern regarding the alarming disparities of minority students pursuing STEM (science, technology, engineering and mathematics) majors and careers. Because of this, researchers are interested in exploring and addressing some of the reasons.

Originality/value – Through the discussion of ideas for action and the proposing of a theoretical foundation from the field of student development, the authors offer recommendations for future research and strategies to further improve recruitment, retention and performance for minority students in STEM fields.

Keywords STEM, Higher education

Paper type Conceptual paper

Introduction

With the rise in attention to diversity, equity and inclusion, recruitment and retention of students from diverse backgrounds has been a focus in current research (Dagley *et al.*, 2015). This has grown increasingly significant in the science, technology, engineering and mathematics (STEM) fields because of the low representation of racial/ethnic minorities studying toward STEM degrees. Although representation is improving, there are still gaps in the research regarding minority students in STEM. According to the National Action Council for Minorities in Engineering (NACME), only 12.5 per cent of engineering degrees were being earned by racial/ethnic minorities (Frehill, 2011). To address this discrepancy, many program efforts have been geared toward recruiting minority students to consider majors in STEM (Hurtado *et al.*, 2010).

Throughout the literature, there is evidence for the importance of focusing on promoting persistence and academic achievement of racial/ethnic minorities in STEM (Elrod and Kezar, 2015; Griffith, 2010; Hurtado *et al.*, 2010; Museus *et al.*, 2011). First, one must consider the numerous barriers related to the environment of predominantly white institutions (PWIs) that have been found to hinder minority students pursuing degrees in STEM (Hurtado *et al.*, 2010). Also imperative to this topic is the need to consider implementation of theoretical framework from the field of student development, as the use of student retention theory has proven effective at historically black colleges and universities (HBCUs) for retaining minority students in STEM (Palmer *et al.*, 2010). Exploring such issues as minority

Journal for Multicultural Education
Vol. 11 No. 2, 2017
pp. 149-159

2053-535X
DOI 10.1108/JME-01-2016-0001

perseverance in STEM and adequately defining success for this population could be advantageous to informing future practice and research.

Through this conceptual paper, solutions are proposed for a number of challenges to racial/ethnic minorities in STEM; current best practices for addressing challenges are discussed; and recommendations offered for future practice and research that will build upon current effective methods of retaining students of color in STEM. Altogether, in addition to the successful programmatic efforts, building upon them by examining this important area of exploration from multiple perspectives are imperative to the increasing of success for racial/ethnic minorities in STEM fields.

Literature review

Barriers and challenges

Throughout the literature, focusing on diversity issues in higher education is the emerging theme that students of color at PWIs face a significant number of challenges associated with racial discrimination and stereotyping (Museus *et al.*, 2011; Hurtado *et al.*, 2010; Solorzano *et al.*, 2000). Many students discontinue their studies in STEM prematurely because of the barriers they experience (Bonous-Hammarth, 2000; Griffith, 2010). These barriers include negative stereotypes about underrepresented minorities (Figueroa and Hurtado, 2013), implicit bias (Moody, 2004; Turner *et al.*, 2008) and established environmental culture(s) and traditions (Harper, 2012; Zambrana *et al.*, 2015). Further, Museus *et al.* (2011) suggest the need to consider the impact of racial discrimination to understand the experiences of students of color. In a study conducted by Strayhorn *et al.* (2013), alienation and invisibility, lack of support from same race peers and faculty, difficulty applying theory and curriculum to practice, as well as few opportunities to do so in introductory engineering courses were identified as barriers for minority students studying STEM. The lack of pre-college preparation for collegiate STEM coursework was also among these barriers. The aforementioned findings provide evidence for a further need to examine these barriers and ways of providing support around them for ethnic minorities in STEM fields.

Financial burden

Research shows that students in STEM are more heavily impacted by financial concerns than their counterparts of different disciplines (Hurtado *et al.*, 2010). Hurtado *et al.* (2010) also concluded that minority students are additionally affected by the financial burden of STEM field course materials and resources. Hurtado *et al.* (2010) noted that racial minority students were inhibited both academically and socially because of financing college. Additionally, Flowers (2004) poses that minorities typically attend low-budget elementary and primary schools that cannot offer sufficient resources to students to support their educational goals. To extend on the conclusion of both of these studies' findings, minority students are at a disadvantage even before beginning to consider attending college. Often times, students who attend low-budget primary schools and live in low-income communities tend to be less informed of financial opportunities (i.e. scholarships, grants and financial aid terminology; St. John *et al.*, 2004). As minority students begin to research and prepare for their undergraduate journey, they often become overwhelmed by the financial process. Minority students often do not have the support necessary to understand the availability of financial support for higher education, thus putting them at a disadvantage from the beginning. Arguably, students who have been given the opportunity to prepare financially, also have more support, and are thus able to focus more on other areas for preparation (St. John *et al.*, 2004).

Along with the challenge of financial burden, minority students in STEM courses need the financial support to purchase materials including books, laboratory materials and/or

technological devices. Statistically, STEM course materials tend to be more expensive than those in other disciplines (Hurtado *et al.*, 2008). In addition to lecture materials, laboratory materials are required for the laboratory sections to offer extensive hands-on curriculum. These materials add to the ongoing financial obstacles presented to minorities. Hurtado *et al.*'s (2010) further findings emphasize the need for further investigation into this challenge for students.

Negative stereotypes and implicit bias

Research indicates that peers largely impact the experiences of racial ethnic minority students in STEM (Bonous-Hammarth, 2000; Hurtado *et al.*, 2007). Students of color often feel pressured by their peers to display their academic capabilities as a result of racial stereotypes (Quaye *et al.*, 2015). Previous research shows that this phenomenon has negatively affected the performance and self-efficacy of minority students. Self-efficacy is described as "the belief in one's capabilities to organize and execute courses of action required to produce given attainments" (Bandura, 1997, p. 3). van Dinther *et al.* (2011) identified that self-efficacy plays a major role in student's achievements, motivation and learning. Hurtado *et al.* (2008) interviewed 45 students at six different universities and found that increased contact with faculty through research experience increased the likelihood of students self-identifying with traits of being a scientist. Therefore, acknowledging and working to address the negative impact of stereotyping may prove beneficial in increased self-efficacy of minorities in STEM, and possibly leading to more representation of this population of students.

Since the inception of higher education institutions, negative stereotyping has shown to hinder students of color. Stereotype threat has been found as a contributing factor in decreased performance of minority students in STEM (Strayhorn *et al.*, 2013). Stereotype threat refers to the fear that one's behavior will conform to an existing stereotype of a particular group in which he or she identifies. This fear has been linked to lesser performance on ability tests (Steele, 1997). Furthermore, many students discussed the low expectations held by faculty of non-minority races, and the detriment this causes to the performance of students (Strayhorn *et al.*, 2013). It is suggested that stronger connections are made with same-race faculty because they are less likely to hold low expectations for members of their own race (Strayhorn *et al.*, 2013). Unfortunately though, there are less opportunities for underrepresented minority students to engage with same-race faculty, because of the low representation of racial minority faculty in STEM (Griffith, 2010).

The role of faculty

Faculty are imperative to the collegiate experience, as faculty support has been found to impact the retention and persistence of Latino males in STEM (Gloria *et al.*, 2005). Moreover, the support, intellectual challenge and encouragement provided by faculty members may lead to the positive perception of the campus (Hurtado *et al.*, 1998). Although research findings demonstrate faculty as exerting positive influence on racial/ethnic minorities (Palmer and Gasman, 2008; Solorzano *et al.*, 2000), faculty have also been found to be responsible for a number of barriers (Elrod and Kezar, 2015).

In addition to the challenges associated with taking on the rigorous STEM major, racial/ethnic minorities also face challenges associated with discrimination and negative interactions with faculty, effects related to coursework, racial climate interactions and the financial concerns of racial/ethnic minorities (Hurtado *et al.*, 2010). Dagley *et al.* (2015) identified the failure for faculty to evaluate and address their implicit biases as problematic. Implicit biases are unconscious responses to particular social groups based on prejudices and previous experiences. Although all humans possess implicit biases, the failure to address implicit biases can lead to negative treatment of students and prejudice behavior.

Undergraduate research

Undergraduate research is a way of encouraging student engagement that enriches the academic experience by helping them to engage in rigorous academic work and providing the opportunity to work closely with faculty on projects that pertain to their interests. Undergraduate research serves as a tool to actively engage and involve students within the University community. Furthermore, Fechheimer *et al.* (2011) found that students involved in undergraduate research showed a higher GPA and higher test scores than students who were not involved, thus establishing a strong, unwavering correlation between undergraduate research involvement and academic success.

Undergraduate research opportunities can provide students with the opportunities needed to engage with same-race faculty. Researchers stress the importance of minority students having access to role models or professionals in their desired positions who are of the same race and same gender (Quaye *et al.*, 2015; Zirkel and Cantor, 2004). Smith (1989) concluded that faculty of color are influential to students of color because they are committed to a more diverse campus climate, play a role in creating comfortable and inclusive environments for other faculty and staff, possess an ability to offer diverse perspectives on teaching and learning and are committed to a pluralistic view of higher education. Research has shown that the majority of minority students, specifically those interested in academia, are affected by the underrepresentation of faculty of color, viewing it as an unattainable profession (Quaye *et al.*, 2015). Therefore, in STEM, it is important for students to be able to see and interact with faculty and peers who look like them and have similar experiences (Strayhorn *et al.*, 2013). This further supports the idea that faculty of color will better know how to serve students of color; that students of color may feel more connected to faculty of color; and that students of color are more likely to feel represented and respected if they see faculty "like them" on the school grounds or college campus (Zirkel and Cantor, 2004).

Current support efforts

Efforts have been aimed toward recruiting minority students into pursuing degrees and careers in STEM through the use of pre-college training and summer bridge programs. Research shows that there is a need to address the areas of knowledge and skill, motivation and support, monitoring and advising and academic and social integration for minorities in STEM (Tsui, 2007). As a result, programs such as the Meyerhoff program and the Minority Engineering program (MEP) have been created to support minorities in STEM.

Programs like Meyerhoff, MEP and the Pre-Accelerated Curriculum in Engineering (PACE) program typically last for six to eight weeks during the summer and provide immersion opportunities for minority students in STEM. STEM preparation programs expose students to the university campus and provide them with an opportunity to network and obtain mentorship from students, faculty and professionals from similar backgrounds. Research shows that participation in the PACE program significantly increases students' rate of persistence to graduation (Palmer *et al.*, 2010). Research on these programs indicate that students who participate in them experience gains in learning and retention (Rotberg, 1990), earn higher grades, obtain degrees at higher rates and attend graduate school at higher rates than racial/ethnic minorities who did not (Maton *et al.*, 2000). Research also has shown that the Meyerhoff program, specifically, was "the first time minority students were afforded an opportunity to be immersed with the presence of prominent Blacks who were striving toward a common academic goal" (Fries-Britt, 1998, p. 564).

Student organizations are also imperative to the success of minority students in STEM. Further, research shows that student leaders and members of student organizations, specifically Black Greek letter organizations, tend to perform better when they are

consciously representing something bigger than themselves (McClure, 2006). A well-known student organization is NACME, which was established in 1974 to develop and catalyze a suite of strategies to increase the participation of underrepresented minorities in engineering. NACME has been effective in recruiting and supporting minority students in STEM. However, research shows that involvement in student organizations outside of the STEM major may lead to negative outcomes often attributed to the misalignment of the values of these organizations and the STEM major for racial/ethnic minorities (Bonous-Hammarth, 2000). Therefore, there is a need to further explore the effectiveness of the STEM-focused student organizations, especially for minorities.

Theoretical viewpoint

Considering the use of theory from the field of student affairs in support programs, student organizations and undergraduate research opportunities is likely to lead to the increasing effectiveness of recruitment and retention of racial and ethnic minorities in STEM. Research conducted by Palmer *et al.* (2010) discusses the implementation of Tinto's (1993) theory of student departure and Astin's (1985) theory of student involvement. Tinto's (1993) theory states that students who are academically and socially integrated into the campus environment are more likely to be able to locate campus resources and develop relationships with their peers, faculty, staff and administrators, which are important to retention and persistence. Similarly, Astin's (1985) theory stresses the role of student involvement in one's development and defines involvement as "the amount of physical and psychological energy that the student devotes to the academic experience" (Astin, 1985, p. 297). He concluded that for student learning and growth to occur, the student must be fully and actively involved in their environment (Evans *et al.*, 2010). He also posits that students involved in college are prone to be academically successful.

Sanford's (1966) concept of challenge and support found that students develop most when they are provided with challenge and are supported by others (professors, mentors, peers and family). Sanford examined the development of students from their interaction with other and the environment and found that too much challenge can lead to underdevelopment of the student and that too much support may result in a lack of developmental growth in the student. Consequently, Tinto's (1993) theory of student departure, Astin's (1985) involvement theory and Sanford's (1966) concept of challenge and support are vital to this work. Sanford (1966) suggested that a balance of challenge and support must be present for development to occur. For example, undergraduate research challenges its students to progress academically through relating their research activities to their coursework. Additionally, student retention programs support Sanford's concept by building self-confidence and providing mentorship. If they encounter problems in their studies, the faculty mentoring the student facilitates support. For student learning growth to take place, students need to actively engage in their environment.

Student development and retention theories suggest that by providing students with opportunities to further engage in the campus environment, the likelihood of their persistence increases. Although these theories do not specifically refer to students of color, it can be expected that these theories apply to the population of reference. These theories point to the importance of working to bridge the gap between academic and student affairs. By intentionally implementing student development and retention theories into the currently effective support efforts such as summer bridge programs, student organizations and undergraduate research, racial and ethnic minorities in STEM fields become better connected to the university and its resources and thus more likely to succeed and persist in STEM.

Discussion

Higher education practitioners and scholars must continue to educate themselves on the diversity presented by minority students, especially those in STEM majors. Research has found that this academic year (2015) should have accepted the most minority students than any other year on record (Hurtado *et al.*, 2008). As STEM majors begin to become more popular among minority students, faculty must continue to develop new techniques to engage and support these students that is more reflective of their cultural background. This discussion will offer a theoretical foundation; implications for policy and practice related to retention of minorities; and implications for future research and practice.

Using student development theory

Tinto's (1993) theory of student departure, Astin's (1985) theory of student involvement and Sanford's (1966) concept of challenge and support all offer points for action for facilitating student persistence, success and retention. Although based on majority white students, each theory can be transferable when helping students achieve academically, especially minorities. Minorities that have not obtained a background knowledge of STEM coursework can become overwhelmed by the challenge presented by the sudden workload. Further engagement can be provided by professors who reach out to the students and develop an action plan to support the students. These interventions are not to discriminate against the students of the majority with less support, but to offer insights into the subconscious struggles of the ill-prepared minority students and how an effort like this manifests in the persistence of those students.

Palmer *et al.* (2010) found that the effort of HBCUs to recruit and retain students in STEM were unique and effective, as they were grounded in student development retention theories. Given this, there is a foundation for intentionally designing programs for racial/ethnic minorities in STEM using student development theory. These theoretical practices allow student affairs practitioners to develop programmatic and organizational activities that allow for minorities to maintain involvement in their field. Further, the practitioners could even collaborate with academic affairs professionals to strengthen the learning outcomes of the activities or events. Some activities can include undergraduate research activities, support programs, summer bridge programs and mentorship. To focus specifically on peer groups, student affairs practitioners are especially adept in creating groups and involvement opportunities. Student affairs practitioners can collaborate with minority students to offer them the opportunity to become involved outside of their classroom with their peers. These groups, with little professor involvement, allow for all students to interact with each other improve their understanding of the materials. However, to utilize the aforementioned theoretical frameworks, minorities must be involved and proportionately challenged and supported, by both their peers and professionals, if they are to persist and succeed in STEM.

Improving current retention programs

According to May and Chubin (2003), successful programs with the potential to increase minority students in STEM majors have and should include all of the following components:

- pre-college student enrichment and intervention programs;
- articles which provide advice and promote preparation approaches;
- teacher effectiveness programs; and
- systemic educational reform initiatives.

From this, one can infer that by continuing similar efforts on college campuses, racial/ethnic minorities will be more likely to flourish in STEM programs.

Of the many formats of retention programs, summer bridge programs are among the most common. However, a shortcoming of summer bridge programs is they typically are operated by science faculty or administrators, who have not received training on or gained an understanding of student development and are presumably concerned with delivering the content only. Hurtado *et al.* (2011) noted that STEM faculty have discussed the lack of time available to focus both on academic requirements of their positions and development of students. While science faculty and researchers are imperative to developing the curriculum and providing the knowledge regarding the material students will learn in class, there is still a need to address the development of students. This is particularly important in supporting minority students in the rigorous STEM field majors. The role of a scientist is important to ensure students are challenged academically throughout their classroom experience in a summer bridge program, but there is also room for partnerships with student affairs professionals to help provide students with support outside of the classroom to foster his or her holistic development simultaneously. This is especially important in programs that serve minority students, as racial/ethnic minority students are faced with a number of new challenges including their transition into college and the challenges associated with being a minority on a PWI campus (Hurtado *et al.*, 2008, 2010).

Bridge programs could benefit from an additional component designed to support the performance of these students once they reach the institution. The use of tracking could be effective in assessing how well students faire in their major after being recruited to the institution. Tracking could also be effective in assessing the need for further support programs for these students, especially those who attend PWIs, where they may be faced with challenges both inside and outside the classroom that may be detrimental to their success.

Minority students often struggle from lack of engagement in their coursework because of their ability to impact and improve their communities. Hurtado *et al.* (2010) found that science courses which were related to minority students' personal lives allowed them to share their knowledge with their communities. Subsequently, this increased the students' rate of success in the STEM fields. STEM courses cover an array of subjects and applications, most of which can only be practiced in specific areas. Unfortunately, many of these areas are not located in the communities the students may have previously identified. To counteract these factors, programs can offer discussion sessions, electives and/or internship opportunities that relate course materials to the potential impacts on the community. These initiatives may also offer collaborative opportunities for an academic unit to partner with student affairs departments. One department in particular, career services, may provide a connection to various organizations in the students' respective communities or surround areas.

Providing undergraduate research experiences

Undergraduate research is important and useful because it can enrich the undergraduate experience, promotes student involvement, can empower students and gives them a sense of control over their lives. Students that enter higher education with ambitions to obtain a degree in STEM fields may need assistance in adjusting to the research-intensive emphasis in their respective programs. Faculty support, which can occur through undergraduate research, has been found to impact the retention and persistence of Latino males in STEM (Gloria *et al.*, 2005) and leads to positive academic outcomes (Fechheimer *et al.*, 2011). Providing these opportunities are important as the support from respected faculty may lead to the positive perception of the campus (Hurtado *et al.*, 1998). Research also demonstrates that undergraduate research challenges students in which support is provided from the faculty who guide them through the research process (Linn *et al.*, 2015). Engaging

underrepresented minority students in STEM with faculty mentors through undergraduate research may be effective in encouraging students to become involved in their major and thus persist to graduation (Hurtado *et al.*, 1998; Gloria *et al.*, 2005). Research projects offer an array of experiences for students and their career interests.

Undergraduate research provides students with an opportunity to gain valuable knowledge from their involvement and hands-on interactions. It also provides an ideal opportunity for faculty to form relationship with students that provide further engagement with the university. Additionally, undergraduate research experiences allow the unique opportunity for professor to identify students' capabilities and challenge students to reach for their goals and educate themselves.

Strengthening faculty–student interactions

STEM majors and careers are regarded as challenging to all students, and students have acknowledged the significant amount of growth fostered in this challenging environment (Hurtado *et al.*, 2008). However, some professors may have difficulty finding a proportionate use of challenge and support for minority students. Furthermore, in many STEM fields, especially at highly ranked universities, a faculty members' research and grant funding is weighted more heavily than teaching, and thus, less emphasis is placed on the development of the student (Hurtado *et al.*, 2011). As a result, many students find themselves unable to find adequate support in getting their questions answered or being provided one-on-one time with faculty. Additionally, the lack of faculty of color only further the challenge of gaining mentorship for minority students.

To address this, faculty can use their resources to offer field experiences to students who show interests. Faculty are expected to offer the best academic environment for their students, and this includes offering resources to students (i.e. anatomy laboratories, physics mechanics and computer laboratory). Faculty can work with first- or second-year students to volunteer their time to arrange these resources for other students. While doing this, the students can gain valuable knowledge from their involvement and hands-on interactions. The professor must identify students' capabilities and challenge students to reach for their goals and educate themselves. If the professor discovers that a specific task is too much for the student, he/she must support the student with resources and empathetic conversations so that the student may reexamine their position with the assignment or coursework.

Addressing financial concerns

Financial burden has been shown as a major factor impacting minority student enrollment and persistence in STEM fields (Hurtado *et al.*, 2010). To increase the quantity of students from diverse racial/ethnic backgrounds who are pursuing studies and careers in STEM, the impact of financial burden must be addressed. Bridging the gap between secondary education and higher education for minority students by providing students with opportunities prior to college to engage in STEM to obtain skills that may lead to funding may be helpful in alleviating the impact of financial concern.

STEM programs with faculty who are passionate about recruiting minorities often receive grants (Hurtado *et al.*, 2008). With this support, minority students are given an opportunity to apply for grants and scholarships through their program or institution; this opportunity can even be extended to apply for outside sources (i.e. federal, state and local funding). Fortunately, STEM majors have an abundance of funding opportunities, as it is a growing and critical field in the workforce. There are many scholarships and grants available to minorities, but there is a lack of advertisement about these opportunities to students. An implication for this factor is to incorporate financial opportunities in the curriculum of first- and second-year courses. Moreover, as beginning courses educate the

students on the basics of the fields, faculty can include the opportunities for their students to collaborate with a faculty or staff member to research and apply for financial support.

Conclusion

To increase successful outcomes for minorities in STEM fields, higher education researchers and practitioners must evaluate the definition of success relative to this population. While success can be defined in many ways, May and Chubin (2003) assert that success for racial/ethnic minorities may include pre-college preparation, recruitment programs, admissions policies, financial assistance, academic intervention programs and graduate school preparation and admission. In this paper, the literature on minority students related to STEM fields were synthesized and presented in topical categories. These included topics such as challenges and barriers, financial issues, stereotypes, the role of faculty and a current support efforts. Following this presentation of literature, ideas for action were discussed, which included the following: a theoretical foundation from the field of student development, bridge programs and student–faculty relationships. By building upon already effective programmatic efforts, looking through a new theoretical lens, developing collaborative partnerships across campus and continuing to develop empirical research on this important area of exploration, institutions of higher education will increase the likelihood of success for racial/ethnic minorities in STEM fields.

References

Astin, A.W. (1985), "Involvement: the cornerstone of excellence", *Change*, Vol. 17 No. 4, pp. 35-39.

Bandura, A. (1997), *Self-efficacy: The Exercise of Control*, W.H. Freeman and Company, New York..

Bonous-Hammarth, M. (2000), "Pathways to success: affirming opportunities for science, mathematics, and engineering majors", *Journal of Negro Education*, Vol. 69 Nos 1/2, pp. 92-111.

Dagley, M., Georgiopoulos, M., Reece, A. and Young, C. (2015), "Increasing retention and graduation rates through a stem learning community", *Journal of College Student Retention: Research, Theory & Practice*, Vol. 1, pp. 1-16.

Elrod, S. and Kezar, A. (2015), "Increasing student success in STEM", *Peer Review*, Vol. 17 No. 2, p. 4.

Evans, N., Forney, D., Guido, F., Patton, L. and Renn, K. (2010), *Student Development in College*, 2nd ed., Jossey-Bass Publication, San Fransisco, CA.

Fechheimer, M., Webber, K. and Kleiber, P.B. (2011), "How well do undergraduate research programs promote engagement and success of students?", *CBE-Life Sciences Education*, Vol. 10 No. 2, pp. 156-163.

Figueroa, T. and Hurtado, S. (2013), "Underrepresented racial and/or ethnic minority (URM) graduate students in STEM disciplines: a critical approach to understanding graduate school experiences and obstacles to degree progression", Rep. Association for the Study of Higher Education, University of California, Los Angeles, November, available at: http://imsd.emory.edu/documents/documents-pdfs/ASHE2013-URM-Grad-Students-in-STEM.pdf

Flowers, L. (2004), "Examining the effects of student involvement on African American college student development", *Journal of College Student Development*, Vol. 45 No. 6, pp. 633-654.

Frehill, L.M. (2011), "African Americans in engineering", *NACME Research & Policy Brief*, Vol. 1 No. 4, pp. 1-2.

Fries-Britt, S. (1998), "Moving beyond Black achiever isolation: experiences of gifted Black collegians", *Journal of Higher Education*, Vol. 69 No. 5, pp. 556-576.

Gloria, A.M., Castellanos, J., Lopez, A.G. and Rosales, R. (2005), "An examination of the academic nonpersistence decisions of Latino undergraduates", *Hispanic Journal of Behavioral Sciences*, Vol. 27 No. 2, pp. 202-223.

Griffith, A.L. (2010), "Persistence of women and minorities in STEM field majors: is it the school that matters?", *Economics of Education Review*, Vol. 29 No. 6, pp. 911-922.

Harper, S.R. (2012), "Race without racism: how higher education researchers minimize racist institutional norms", *The Review of Higher Education*, Vol. 36 No. 1, pp. 9-29.

Hurtado, S., Milem, J.F., Clayton-Pedersen, A.R. and Allen, W.R. (1998), "Enhancing campus climate for racial/ethnic diversity: educational policy and practice", *The Review of Higher Education*, Vol. 21 No. 3, pp. 279-302.

Hurtado, S., Newman, C.B., Tran, M.C. and Chang, M.J. (2010), "Improving the rate of success for underrepresented racial minorities in STEM fields: insights from a national project", *New Directions for Institutional Research*, Vol. 2010 No. 148, pp. 5-15.

Hurtado, S., Han, J.C., Sáenz, V.B., Espinosa, L.L., Cabrera, N.L. and Cerna, O.S. (2007), "Predicting transition and adjustment to college: biomedical and behavioral science aspirants' and minority students' first year of college", *Research in Higher Education*, Vol. 48 No. 7, pp. 841-887.

Hurtado, S., Eagan, K., Cabrera, N., Lin, M., Park, J. and Lopez, M. (2008), "Training future scientists: predicting first-year minority student participation in health science research", *Research in Higher Education*, Vol. 2008 No. 49, pp. 126-152.

Hurtado, S., Eagan, M.K., Tran, M.C., Newman, C.B., Chang, M.J. and Velasco, P. (2011), "We do science here: underrepresented students' interactions with faculty in different college contexts", *The Journal of Social Issues*, Vol. 67 No. 3, pp. 553-579.

Linn, M.C., Palmer, E., Baranger, A., Gerard, E. and Stone, E. (2015), "Undergraduate research experiences: impacts and opportunities", *Science*, Vol. 347 No. 6222, doi: 10.1126/science.

McClure, S.M. (2006), "Voluntary association membership: black Greek men on a predominantly white campus", *Journal of Higher Education*, Vol. 77 No. 6, pp. 1036-1057.

Maton, K.I., Hrabowski, F.A. and Schmitt, C.L. (2000), "African American college students excelling in the sciences: college and post college outcomes in the scholars post-college Meyerhoff Scholars program", *Journal of Research in Science Teaching*, Vol. 37 No. 7, pp. 629-654.

May, G.S. and Chubin, D.E. (2003), "A retrospective on undergraduate engineering success for underrepresented minority students", *Journal of Engineering Education*, Vol. 92 No. 1, pp. 27-39.

Moody, J. (2004), *Faculty Diversity: Problems and Solutions*, Routledge, New York, NY.

Museus, S.D., Palmer, R.T., Davis, R.J. and Maramba, D. (2011), "Special issue: Racial and ethnic minority student success in STEM education", *ASHE Higher Education Report*, John Wiley & Sons, Hoboken, NJ.

Palmer, R.T. and Gasman, M. (2008), "It takes a village to raise a child: the role of social capital in promoting academic success for African American men at a Black college", *Journal of College Student Development*, Vol. 49 No. 1, pp. 52-70.

Palmer, R.T., Davis, R.J. and Thompson, T. (2010), "Theory meets practice: HBCU initiatives that promote academic success among African Americans in STEM", *Journal of college student development*, Vol. 51 No. 4, pp. 440-443.

Quaye, S.J., Griffin, K.A. and Museus, S.D. (2015), "Engaging students of color", in Quaye, S. and Harper, S. (Eds), *Student Engagement in Higher Education: Theoretical Perspectives and Practical Approaches for Diverse Populations*, Routledge, New York, NY, pp. 17-35.

Rotberg, I.C. (1990), "Resources and reality: the participation of minorities in science and engineering education", *Phi Delta Kappan*, Vol. 71, pp. 672-679.

Sanford, N. (1966), *Self and Society: Social Change and Individual Development*, Atherton Press, New York, NY.

Smith, D. (1989), "The challenge of diversity: involvement or alienation in the academy?", ASHE-ERIC Higher Education Report No. 5, The George Washington University, Graduate School of Education and Human Development, Washington, DC.

Solorzano, D., Ceja, M. and Yosso, T. (2000), "Critical race theory, racial microaggressions, and campus racial climate: the experiences of African American college students", *Journal of Negro Education*, Vol. 69 Nos 1/2, pp. 60-73.

St. John, E., Hu, S., Simmons, A., Carter, D. and Weber, J. (2004), "What difference does a major makes? The influence of college major field on persistence by African American and White students", *Research in Higher Education*, Vol. 45 No. 3, pp. 209-232.

Steele, C.M. (1997), "A threat in the air: how stereotypes shape intellectual identity and performance", *American Psychologist*, Vol. 52 No. 6, p. 613.

Strayhorn, T.L., Long, L.L. III, Kitchen, J.A., Williams, M.S. and Stentz, M.E. (2013), "Academic and social barriers to Black and Latino male collegians' success in engineering and related STEM fields", *American Society for Engineering Education Annual Conference and Exposition, Atlanta, GA*, June, available at: asee.org

Tinto, V. (1993), *Leaving College: Rethinking The Causes and Cures of Student Attrition*, 2nd ed., University of Chicago Press, Chicago.

Tsui, L. (2007), "Effective strategies to increase diversity in STEM fields: a review of the research literature", *The Journal of Negro Education*, Vol. 76 No. 4, pp. 555-581.

Turner, C.S.V., Gonzalez, J.C. and Wood, J.L. (2008), "Faculty of color in academe: what 20 years of literature tells us", *Journal of Diversity in Higher Education*, Vol. 1 No. 3, pp. 139-168.

van Dinther, M., Dochy, F. and Segers, M. (2011), "Factors affecting students' self-efficacy in higher education", *Educational Research Review*, Vol. 6 No. 2, pp. 95-108.

Zambrana, R.E., Ray, R., Espino, M.M., Castro, C., Cohen, B.D. and Eliason, J. (2015), "Don't leave us behind: the importance of mentoring for underrepresented minority faculty", *American Educational Research Journal*, Vol. 52 No. 1, pp. 40-72.

Zirkel, S. and Cantor, N. (2004), "50 years after Brown v. Board of Education: the promise and challenge of multicultural education", *Journal of Social Issues*, Vol. 60 No. 1, pp. 1-15.

Further reading

Lopatto, D. (2007), "Undergraduate research experiences support science career decisions and active learning", *CBE Life Sciences Education*, Vol. 6 No. 4, pp. 297-306, available at: http://doi.org/10.1187/cbe.07-06-0039

Maton, K.I., Pollard, S.A., McDougall Weise, T.V. and Hrabowski, F.A. (2012), "The Meyerhoff scholars program: a strengths-based, institution-wide approach to increasing diversity in science, technology, engineering and mathematics", *The Mount Sinai Journal of Medicine*, Vol. 79 No. 5, pp. 610-623, available at: http://doi.org/10.1002/msj.21341

Mendez, G., Burkirk, T.D., Lohr, S. and Haag, S. (2008), "Factors associated with persistence in science and engineering majors: an exploratory study using classification trees and random forests", *Journal of Engineering Education*, Vol. 97 No. 1, pp. 57-70.

Corresponding author

Megan Covington can be contacted at: mncoving@gmail.com