Persistence Among Minority STEM Majors: A Phenomenological Study

Stacey Williams

ABSTRACT

The United States needs to increase the number of science, technology, engineering, and math (STEM) graduates to remain competitive in the global market and maintain national security. Minority students, specifically African-American and Hispanic, are underrepresented in STEM fields. As the minority population continues to grow it is essential that higher education institutions improve minority students' persistence in STEM education. This study examined the problem of minority students' lack of persistence in STEM programs, focusing and building on the theoretical framework for student retention. The purpose of this qualitative transcendental phenomenological study was to describe the lived experiences that minority students perceived as contributing to their persistence in STEM. The central research question was: What are the lived experiences of minority STEM students that have contributed to their persistence in a STEM program? The researcher interviewed 12 minority STEM students and uncovered 10 themes: 1) Childhood experiences and interests; 2) Positive educational experiences in secondary school; 3) Self-motivation; 4) Positive experiences with professors; 5) Family encouragement and values; 6) Lack of minorities; 7) Lack of educational preparation; 8) The need for financial assistance; 9) Clubs and organizations; and 10) Friends within the major. The significance of these findings is the potential to produce changes in curricula, programs, and retention methods in hopes of improving minority students' persistence in STEM programs.

Introduction

The ability to produce Science, Technology, Engineering, and Math (STEM) graduates who can compete in the ever-changing global market and maintain national security is a major concern of the United States of America's government officials (Chen, 2009; Gonzalez & Kuenzi, 2012; McGlynn, 2012; Palmer, Maramba, & Dancy II, 2011). According to Palmer, Davis, and Thompson (2010) and McGlynn (2012), faculty and administration in higher education institutions within the United States (U.S.) will need to produce more STEM graduates. One of the concerns facing higher education administrators is the lack of minority students enrolled and persisting in STEM programs (Museus & Liverman, 2010).

While historical trends can speak about the phenomena of retention and persistence in college, issues still arise when comparing the experiences of minorities to the majority population. The barriers and obstacles that minority students are facing continue to far outnumber their majority counterparts. The implications of these experiences are college dropout or change of major. To help alleviate this problem and ensure persistence in STEM programs for minority students, higher education institutions need to consider the minority students' perspectives.

This research aligns well with the *Standards for Teacher Educators* produced by the Association of Teacher Educators (ATE) focusing specifically on Standard 2: Cultural Competency. According to the ATE Standards, cultural competency should exhibit practices that enhance an understanding of diversity and instruction meeting the needs of society, model ways to reduce prejudice, and promote inquiry into culture and differences. This study focused on the lived experiences of minority students in hopes of learning about their educational experiences and their cultural differences to provide change in curricula and professional development to ensure minority students persist in STEM programs.

Theoretical Framework

The phenomenon of student retention is not a new problem in higher education. Spady (1970) developed a theoretical synthesis regarding dropouts based on Durkheim's theory of suicide. Durkheim's theory of suicide claimed that failure of an individual to acclimate into society can cause them to commit suicide (Pope, 1975; Poppel & Day, 1996). Spady's Sociological Model of the Dropout Process begins with the assumption that students dropping out of college do so because of the interrelationships in college including both academic and social systems (Spady, 1970; Spady, 1971). Bean also developed a model that indicated the rate of student retention was dependent on the type of student who entered college and their background (Bean, 1979; Bean & Bean, 2007).

Swail, recognizing the limitations of the previous models as well as their complexity, developed a "user-friendly" method (Swail, 1995, Swail et al., 2003; Swail, 2004). Swail developed a Geometric Model of Student Persistence and Achievement, the three-dimensional triangle showed each side representing a different force that affects student experiences, cognitive, social, and institutional forces. The cognitive side considers the students' academic ability and content knowledge. The social side refers to a student's ability to interact with others, and the third side, institutional factors refers to the practices and strategies that an institution incorporates, including recruitment, curricula, student services, and financial services (Swail, 1995). The center of the triangle focused on the student's experiences (Swail et al., 2003; Swail, 2004).

History of STEM

The U.S. Government has always had an interest in STEM, in the1800s, the U.S. began offering engineering degrees from Military Academy-West Point, Norwich University (under a different name), and Rensselaer Polytechnic Institute (Engineering Your Future, n.d.). These graduates played a major part in designing many of the roads, railroads, and bridges in the U.S. (Jolly, 2009).

In 1950, Congress passed the National Science Foundation Authorization Act encouraging research and science education (Gonzalez & Kuenzi, 2012). After the Soviet Union launched Sputnik into space in 1958; the U.S. passed the National Defense Education Act (NDEA), providing funding to improve schools and meet the demands of national security (Encyclopedia Britannica, 2015). The government continued to pass STEM related acts and in 2009, the Obama administration, introduced the "Educate to Innovate" campaign designed to improve performance and participation in the STEM fields (Chen, 2013).

According to the President's Council of Advisors on Science and Technology (2012), the economy is projected to need an additional one million more STEM professionals than the U.S. is currently producing. This gap will increase as student enrollment in STEM programs decline, and such a decline could put the U.S. at risk of not being able to compete with other countries (Palmer et al., 2011), and maintain national security (Gonzalez & Kuenzi, 2012). In addition, if the U. S. is not producing STEM graduates they will have to outsource many STEM jobs (Chubin et al., 2005).

According to Science and Engineering Indicators (2018), in 2017 the U.S. graduated 680,000 students with Bachelor degrees in STEM fields which was an increase from past years, however, this is not enough to fill the increasing gap. To meet the current demand, the U.S. will need to work towards increasing the number of STEM graduates (The President's Council, 2012). Hrabowski and Henerson (2017), emphasized that to reach these goals higher education institutions must choose the path of inclusive excellence in STEM education by providing financial support, social integration, and professional development. To help alleviate the problem, In 2017 Trump signed a memorandum that expanded and improved access to STEM education and Computer Science for students in grades K-12 (The White House, 2017).

STEM Retention

Retention is not a new problem in higher education institutions as theorists including Spady (1970, 1971), Tinto (1975, 1982), and Bean (1979, 2007) have focused on student retention since the early 1970s. Swail however, focused on the limitations of past studies and developed a model that focused on student persistence and achievement, with an emphasis on minority students in STEM (Swail, 1995, Swail et al., 2003; Swail, 2004).

According to Chen (2013), the Statistical Analysis Report identified that in the 2003-2004 academic school year 28% of students entering a bachelors program majored in a STEM field. However, 48% of the 28% left the STEM field by either changing majors or dropping out completely. When looking at minorities these numbers are lower as only 13% of minorities major in STEM and only 24% of those students persisted in STEM (Foltz et al., 2014). Minority students enroll in STEM majors in smaller numbers and often leave in high numbers (Alkhasawneh & Hargraves, 2014; Griffith, 2010) with the majority of student attrition occurring in the first 2 years of college (Watkins & Mazur, 2013; Gasiewski et al., 2012). It is through retaining minority students in STEM programs that higher education institutions will be able to increase the number of minority students graduating from STEM (Alkhasawneh & Hargraves, 2014).

STEM Studies

Many current STEM studies are broken into two basic categories; there are studies identifying which students intend to major in STEM and studies identifying possible barriers to majoring in STEM.

Looking at who enters the STEM fields, the U.S. Department of Education conducted research. The results exposed that African-Americans ranked one of the lowest groups to enter the STEM field at 20.8% ranking only slightly above American Indian/Alaska Native at 19.1% (Chen, 2009). The National Science Foundation report (2015) also explained that many undergraduate minorities are the first in their family to attend college.

Wang (2013), conducted research that examined why students choose STEM majors. The results revealed that the intent to major in STEM was positively influenced by self-efficacy and exposure to math and science in high school. In addition, the research showed that those who choose to major in STEM in postsecondary school were college-ready specifically in math and science and often receiving financial aid. The research goes on to discuss the importance of motivational attributes including attitudes toward STEM, self-efficacy, and intent to pursue STEM (Wang, 2013). Another study by Whalen and Shelley (2010), revealed that 73% of STEM students remained in STEM programs, compared to 92% of non-STEM majors. The study also reinforced predictors like demographic, environmental, and financial aspects influencing STEM retention.

Recent work around STEM and Expectancy Value Theory (EVT), a theory that claims a students' ability to be successful in a subject relies on his or her ability to believe that he or she can succeed has also aided this study. According to Ball et al., (2017) and Collins et al., (2020) minority STEM students that have had early exposure to STEM and exhibited feelings of connectedness to STEM are more likely to pursue and excel in STEM.

Many minorities who major in STEM are faced with barriers and obstacles that often prevent them from persisting in STEM and graduating. Beasley and Fischer (2012), conducted a study to determine why minorities and women leave STEM focusing on the idea of social-psychological barriers, specifically stereotyping (Beasley & Fischer, 2012). The research showed that stereotyping affected minority students negatively during test taking, causing performance anxiety, but also during life experiences, as many minorities believed that their White classmates did not believe they should be there and were only there due to legislation like affirmative action (Beasley & Fischer, 2012).

Another study conducted by Chen (2013), also focused on barriers. The study revealed that parental educational attainment was a factor, as many students whose parents had only a high school diploma or less, departed from STEM programs compared to those with more education. Banerjee (2016), shared that family factors also contributed, as students who come for low income, high poverty families were less likely to be encouraged to attend college or major in STEM. Additional barriers that were revealed, included the lack of academic preparation (Arcidiacono & Hotz, 2016). According to the U. S. Census Bureau (2018), approximately 22.5% of Blacks and 18.8% of Hispanics are below the poverty level compared to only10.9% of Whites. Given these barriers minority students tend to be less likely to obtain STEM degrees. A survey conducted by Bayer Corporation (2012), identified that U.S. colleges often discourage minority students from continuing in STEM claiming 40% of women and minorities have been discouraged from pursuing a STEM degree in chemistry or chemical engineering.

One major factor missing from the majority of studies is the students' perspectives, specifically the minority students' perspectives. In addition, very few studies tend solely to focus on students' persistence in STEM and even fewer focus on minority students. Therefore, there is a lack of literature focusing on persistence in STEM and minorities (McGlynn, 2012).

Research

The researcher conducted a qualitative, transcendental, phenomenological study. The purpose of the study was to describe the lived experiences that minority students perceive as contributing to their persistence in STEM programs.

Statement of Problem

A report presented by the President's Council of Advisors on Science and Technology (2012), claimed that if the U.S. is going to maintain its economic, social, and national security levels, government and higher education institutions will need to work towards increasing the number of students receiving STEM degrees by 34% yearly. Palmer et al. (2010), also expressed concerns about the lack of students receiving STEM degrees, and asserted that the increase of STEM graduates will need to come from the minority population to meet the STEM demands (Palmer et al., 2010). The problem is that many minority students do not persist in higher education STEM programs.

Research Questions

The central research question was as follows:

- What are the lived experiences of minority STEM students that have contributed to their persistence in a STEM program?

Sub Questions:

- What led participants to major in STEM

- What contributed to students' success and persistence in STEM?
- What advice do students have to offer?

Methodology

In an attempt to answer the research questions, the researcher conducted a phenomenological study. The study explored minority students' persistence in STEM programs through their lived experiences.

Population and Sampling

In phenomenological studies, the sample population must come from individuals who have experienced the phenomenon (Smith et al., 2013). To accomplish this task, the sample population came from a public university in Connecticut with STEM affiliations, which shall remain nameless as per the institution's request. The researcher approached the Director of Clubs and Organizations who shared the invitation with clubs that fit the demographic. This yielded one participant who then shared the invitation with classmates, using the snowball method.

The researcher was able to interview a total of 12 participants. The study's participants were minority students, specifically African-Americans and Latinos enrolled in STEM programs. Participants were juniors, seniors, and/or recent graduates of STEM programs. The participants were interviewed one-on-one in a mutually agreed upon location. The interviews lasted between 30 – 60 minutes and the interviewer recognized the behavior patterns and reactions of the participants. All interviews were conducted within a three-month timeframe. The 12 participants were given pseudonyms to protect their identity and details from the study and interviews are described below.

Data Analysis

The study consisted of nine semi-structured, open-ended interview questions. The researcher recorded the interviews with participants' permission, transcribed them, and verified them for accuracy via email. The researcher then extracted common themes using NVivo 11 (a platform for analyzing qualitative data). NVivo 11 software allowed the researcher to use pattern-based auto coding to help reduce natural bias. The ten themes that emerged were: 1) Childhood experiences and interest 2) Educational experiences in secondary school; 3) Self-motivation; 4) Positive experiences with professors; 5) Family encouragement and values; 6) Lack of minorities; 7) Lack of educational preparation; 8) The need for financial assistance; 9) Clubs and organizations; and 10) Friends within the major. The themes that emerged were able to answer the research questions.

Summary of Findings

The findings are organized below by sub-questions; under each sub-question are the corresponding interview questions with the themes that emerged, and some students' quotes.

Interview Question 1: What led you to major in STEM?

When participants were asked question 1, two themes emerged, childhood experiences and interest and educational experiences in secondary school. These themes appeared to recall positive experiences when the participants were younger. Dione, one of the participants shared, "I always liked science, since I was a kid; I liked to do all of my own little experiments". "When I was in high school, I was always good at math and science, I like science a lot and physics was really fun for me," shared Colet, another participant.

Interview Question 2 & Interview Question 3: What are the top four experiences that have contributed to your persistence in your STEM program (think specifically about your first 2 years as a STEM major)? How specifically did each of those (four) experiences contribute to your persistence in your STEM program?

Interview Questions 2 and 3 were combined as Question 3 was a follow-up question to Question 2. Responses revealed many different experiences for the participants, some positive and some negative. The most persistent two themes indicated for these questions were the focus during the analytical process. The first theme, self-motivation, was the most prominent theme and was indicated various times by participants throughout the interview process. For the purpose of the study, the term self-motivation referred to a student's drive or passion, a force that keeps them going and pushes them to move forward. "All in all, I know that I have to push myself, I have to keep on going, a lot of my support comes from me; I have to think, do I really want this, I have to push myself" a participant Kaiser shared. Freeman et al., (2008), also confirmed that students' self-efficacy was strongly related to positive motivation.

Interview Question 4: In what way(s) do you think the experiences you just shared relate to being a minority student in a STEM program?

When students were asked question 4, their thoughts and ideas tended to focus around three themes, the lack of minorities in STEM majors, their lack of preparation for STEM classes, and the need for financial assistance. A study conducted by Charleston (2012), focused on barriers of minority students; claiming students felt they were not prepared for college, but felt they were especially weak in both mathematics and the sciences. Participants shared, "I noticed the first year I had a lot more African Americans and other minorities in my classes and as we progressed it became less and less; less people like me" claimed Kerry. Another participant focusing on the lack of educational preparation shared, "When I came out of school, I had a 2.0 GPA, and I did really bad on my SATs. When I started this program, I had to go through an education opportunity program. It is basically for students who did poorly", claimed Jasun. Other participants shared the need to work to pay for school claiming it took away from study time.

Interview Question 5: What support did you receive from the school that assisted you in persisting in your STEM program?

This question seemed to stump participants as many felt they did not receive much support from their school. However, after some time students began to share and three themes emerged, positive experiences with professors, clubs and organizations, and friends within the major. Waverly shared, "my professors, they helped me out a lot; there were times I stayed after class for about two hours, and still they stayed and helped me". While Kerry focused on the actual school claiming, "my school, they have a good set of cultural and activity clubs which helped me persist...that gave me a sense of community". A study conducted by Freeman et al., (2008) confirmed that linked classes and learning communities are beneficial to African-American students as they seek to enhance engagement and retention.

Interview Question 6: What support outside of school did you receive that has helped you persist in your STEM program?

Two reoccurring themes showed up when asking students question 6; self-motivation and family encouragement and values. All twelve students mentioned family support and five of the twelve students mentioned self-motivation again, as they believed that without self-motivation they could not have made it thus far. Kaiser shared the strong family bond claiming, "Family told me to keep on going, they understand it is really difficult... I am a fifth-year college student".

Interview Question 7: Do you believe any of the support you received either from the school or outside of the school was specifically related to you being a minority? Explain?

Participants shared theme 5 again, family experiences and encouragement. Participants focused on family members reminding participants that they are a minority and that they need to work harder than others. Whereas, others discussed being religious and having a high value system. A study conducted by Peralta et al, (2013), reaffirmed the importance of a family unit and support in encouraging persistence in college.

Interview Question 8: What advice would you give to new students in a STEM program to help them persist in the program?

Participants smiled when asked this question and all twelve participants agreed on one thing, the recurrence of theme 3: self-motivation.

Interview Question 9: What advice do you have for university leaders who want to help improve minority student's retention in STEM programs?

Participants loved the idea of sharing their thoughts and ideas with university leaders, although some were skeptical that university leaders would listen. Participants came up with a list of suggestions that seemed to be closely related to their experiences and the themes discussed earlier in the chapter.

The findings from the study were consistent with many of the major points presented in the review of literature with a focus on Swail's model that focused on three factors: cognitive, social, and institutional (Swail et al., 2003; Swail, 2004). All ten themes either directly or indirectly could be categorized into Swail's model. Cognitive factors included lack of minorities and lack of preparation. Social factors included friends within the major, family encouragement, childhood experiences, and the need for financial assistance. Finally, institutional factors include clubs and organization, experiences with professors, and experiences in secondary school. The only theme that did not seem to fit neatly into Swail's model is self-motivation which happened to be the most prominent theme.

Significance

The significance of this study is its ability to offer recommendations that potentially could inform government leaders and higher education leaders on ways to make adjustments to curriculum, professional development, and retention methods in hopes of increasing the persistence of minority students in STEM.

Recommendations

1. Communicate with students – Talk to students and find out what needs they have.
2. Have a diverse group of faculty – This will allow students to see people like themselves (Leone & Tian, 2009; Beasley & Fischer, 2012; Griffin et al., 2012; Griffith, 2010).
3. Assign peer mentors – Have juniors and seniors mentor freshmen and sophomores (Griffith, 2010; Yelamarthi & Mawasha, 2010).
4. Financial assistance - Offer financial assistance, grants, scholarship, etc. (Swail, 2004; Milem, Chang & Antonio, 2005; Fotlz et al., 2014).

Summary and Conclusion

The United States history is filled with innovation. The ability to create, develop and improve upon things is part of what makes the U.S. competitive. In order for the U.S. to remain a competitive force they will need to produce more STEM graduates. To help alleviate the situation it is recommended that the U.S. increase the number of STEM graduates and that these graduates come from the minority population as they are expected to be the majority population in the near future. Therefore, administrators need to find ways to help STEM minority students persist in STEM programs; the researcher believed it was important to go to the source to help produce a solution.

The researcher used a qualitative, phenomenological approach to describe the lived experiences that minority students perceive as contributing to their persistence in STEM programs. Twelve juniors, seniors, and recent graduates of STEM programs were interviewed. The data revealed 10 themes of persistence for minority STEM students. Based on the results of the current study, administrators can make strides to improve upon STEM persistence for minority students. Taking advice from the participants and listening to their experiences aided the researcher in developing advice to offer to university leaders to help minority students' persistence. The researcher developed four basic recommendations that universities can use to help improve the minority student persistence in STEM programming. First administrators and leaders need to communicate with the actual students at his or her institution to determine the students' specific needs. Every institution is different, therefore they attract a different type of student. Talk to the students and determine their needs, give them a voice. Second, improve staff diversity, this means hiring diverse staff that look like your students. Third, develop a mentorship program where minority juniors and seniors mentor incoming freshman and sophomores. Finally, offer students grants and financial aid opportunities that would allow students to concentrate fully on classes. These suggestions, although simple, have a good chance of making a difference in improving minority student persistence. However, as with any recommendations, more research would need to be done to determine if these methods could actually improve minority student persistence.

References

Alkhasawneh, R., & Hargraves, R. H. (2014). Developing a hybrid model to predict student first year retention in STEM disciplines using machine learning techniques. *Journal of STEM Education, 15*(3), 35-42.

Antonio, A. L., Chang, M. J., Hakuta, K., Kenny, D. A., Levin, S., & Milem, J. F. (2004). Effects of racial diversity on complex thinking in college students. *Psychological Science, 15*(8), p. 507-510. Retrieved from http://www.jstor.org/stable/40064007

Arcidiacono, P., Aucejo, E. M., & Hotz, V. J. (2016). University differences in the graduation of minorities in STEM fields: Evidence from California. *American Economic Review, 106*(3), 525-562. doi:http://dx.doi.org.contentproxy.phoenix.edu/10.1257/aer.106.3.525

Ball, C., Huang, K.-T., Cotten, S., & Rikard, R. V. (2017). Pressurizing the STEM pipeline: an expectancy-value theory analysis of youths' STEM attitudes. *Journal of Science Education & Technology*, 26(4), 372–382. https://doi.org/10.1007/s10956-017-9685-1

Banerjee, P. A. (2016). A systematic review of factors linked to poor academic performance of disadvantaged students in science and maths in schools. *Cogent Education*, 3(1), 1178441.

Bayer Corporation. (2012). Bayer facts of science education XV: A view from the gatekeepers-STEM department chairs at America's top 200 research universities on female and underrepresented minority undergraduate STEM students. *Journal of Science Education & Technology, 21*(3), 317-324. doi:10.1007/s10956-012-9364-1

Bean, J. (1979). *Dropouts and turnover: The synthesis and test of a casual model of student attrition.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, California.

Bean, J., & Bean, B. (2007). College student attrition and retention. In gender and education: *An encyclopedia*. Santa Barbara, CA: ABC-CLIO.

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math, and engineering majors. *Social Psychology Education,* 15, 427-448.

Charleston, L. J. (2012). A qualitative investigation of African Americans' decision to pursue computing science degrees: Implication for cultivation career choice and aspiration. *Journal of Diversity in Higher Education*, *5*(4), 222-243.

Chen, X. (2009). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education*. NCES 2009-161. National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Chen, X. (2013). *STEM Attrition: College students' paths into and out of STEM fields*. NCES 2014-001. National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC. Retrieved from http://nces.ed.gov/pubs2014/2014001rev.pdf

Chubin, D. E., May, G. S., & Babco, E. L. (2005). Diversifying the engineering workforce. *Journal of Engineering Education*, *94*(1), 73-86.

Collins, M. A., Totino, J., Hartry, A., Romero, V. F., Pedroso, R., & Nava, R. (2020). Service-Learning as a lever to support STEM engagement for underrepresented youth. *Journal of Experiential Education*, 43(1), 55–70.

Crisp, G., Nora, A., & Taggart, A. (2009). Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a Hispanic serving institution. *American Educational*

Research Journal, 46 (4), 924-942. Retrieved from http://serach.proquest.com/docview/200370913? Accountid=458

Cromley, J. G., Perez, T. Wills, T. W., Tanaka, J. C., Horvat, E. M., & Agbenyega, E. T. (2013). Changes in race and sex stereotypes threat among diverse STEM students: Relation to grades and retention in the majors. *Contemporary Educational Psychology*, *38*, 247-257.

CT Dept. of Labor (2012). *Math & Science Knowledge and Skills: Catalysts for Future Economic Growth Within Connecticut.* Retrieved from https://www1.ctdol.state.ct.us/lmi/pubs/math_science.pdf

Foltz, L. G., Gannon, S., & Kirschmann, S. (2014). Factors that contribute to the persistence of minority students in STEM fields. *Planning For Higher Education*, *42*(4), 46-58.

Freeman, K. E., Alston, S. T., & Winborne, D. G. (2008). Do learning communities enhance the quality of students' learning and motivation in STEM? *The Journal of Negro Education, 77*(3), 227-240. Retrieved from http://search.proquest.com/docview/222068511?accountid=458

Gasiewski, J. A., Eagan, M. K., Garcia, G. A., Hurtado, S., & Chang, M. J. (2011). From gatekeeping to engagement: A multicontextual, mixed method study of student academic engagement in introductory STEM courses. *Research in Higher Education, 53*, 229-261. doi:10.1007/s11162-011-9247-y

Gilbert, J. E., & Lewis, C. W. (2008). An investigation of computational holistic evaluation of admission applications for a minority focused STEM research program. *Journal of STEM Education, 9*(1&2), 40-47.

Giving every child a fair shot: Progress under the Obama administration's education agenda. (2016). Retrieved from https://www.whitehouse.gov/sites/default/files/docs/giving_every_child_fair_shot_050316.pdf

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economic of Education Review*, *29*, 911-922

Griffin, K. A., Perez, D., Holmes, A. P. E., & May, C. E. P. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. *New Direction Institutional Research*, *148*, 95-103.

Gonzalez, H. B. & Kuenzi, J. J. (2012). Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer. *Congressional Research Service*. Retrieved from http://www.stemedcoalition.org/wp-content/uploads/2010/05/STEM-Education-Primer.pdf

Hrabowski III, F. A., & Henderson, P. H. (2017). Toward a more diverse research community models of success: A forward-looking group of colleges and universities are demonstrating effective ways to educate underrepresented minorities for careers in science and engineering. *Issues in Science & Technology*, 33(3), 33.

History of Engineering. (n.d.). *Engineering Your Future*. Retrieved from http://www.futuresinengineering.com/what.php?id=1

Huang, G., Taddese, N., and Walter, E. (2000). *Entry and persistence of women and minorities in college science and engineering education.* NCES 2000-601. National Center for Education Statistics, U.S. Department of Education. Washington, DC. Retrieved from http://nces.ed.gov/pubs2000/2000601.pdf

Jolly, J.L. (2009). The national defense education act, current stem initiative, and the gifted. *Gifted Child Today*, *32*(2), 50-53.

Krishnamurthi, M. (2003). Assessing multicultural initiative in higher education institutions. *Assessment & Evaluation in Higher Education, 28(3*), p. 263-277.

Leone, M., & Tian, R. G. (2009). Push vs. pull: Factors influence student retention. American *Journal of Economics and Business Administrations, 1*(2), p. 122-132.

Maramba, D. C. (2008). Understanding campus climate through the voices of Filipana/o American college students. *College Student Journal*, *42*(4), 1045-1060.

McGlynn A. P. (2012). Minority student shortage in science and technology. *The Hispanic Outlook in Higher Education, 22*, 8-9.

Milem, J. F., Chang, M. J., & Antonio, A. L. (2005). Making diversity work on campus: A research-based perspective. *Association of American Colleges and Universities*. Retrieved from https://siher.stanford.edu/AntonioMilemChang_makingdiversitywork.pdfhttp://searchproquest.com/docview/202819686?accountid=458

Museus, S. D., & Liverman, D. (2010). High-performing institutions and their implications for studying underrepresented minority students in STEM. *New Directions for Institutional Research, 148,* 17-27.

National, A. O. E. S., & Committee, O. D. I. T. E. (2002). *Diversity in Engineering: Managing the Workforce of the Future.* Washington, DC, USA: National Academies Press. Retrieved from http://www.ebrary.com

National Defense Education Act (NDEA). (2015). *In Encyclopedia Britannica*. Retrieved from http://www.britannica.com/EBchecked/topic/404717/National-Defense-Education-Act-NDEA

National Science Board. (2014). *Science and Engineering Indicators 2014*. Arlington VA: National Science Foundation Science and Engineering Indicators 2014: S & E Bachelor's degrees, by field: 2000-11. Retrieved from http://www.nsf.gov/statistics/seind14/index.cfm/appendix/tables.htm

National Science Board. (2018). *Science and Engineering Indicators* 2018. NSB-2018-1. Alexandria, VA: National Science Foundation. Retrieved from https://ncses.nsf.gov/pubs/nsb20197/trends-in-undergraduate-and-graduate-s-e-degree-awards

National Science Foundation. National center for science and engineering statistics directorate for social, behavioral and economic Sciences. (2015). *Women, minorities, and persons with disabilities in science and engineering 2015 report*. Retrieved from www.nsf.gov/statistics/wmpd/

Palmer, R. T., Davis, R. J., & Thompson, T. (2010). Theory meets practice: HBCU initiatives that promote academic success among African Americans in STEM. *Journal of College Student Development, 51*(4), 440-443.

Palmer, R. T., Maramba, D. C., & Dancy, T. (2011). A Qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *Journal of Negro Education, 80*(4), 491-504.

Peralta, C., Caspary, M., & Boothe, D. (2013). Success factors impacting Latina/o persistence in higher education leading to STEM opportunities. *Cultural Studies of Science Education, 8*(4), 905-918. doi:http://dx.doi.org/10.1007/s11422-013-9520-9

Pope, W. (1975). Concepts and explanatory structure in Durkheim's theory of suicide. *British Journal of Sociology*, *26*(4), 417-434.

Poppel, F., & Day, L. H. (1996). A test of Durkheim's theory of suicide-without committing the "ecological fallacy". *American Sociological Review*, *61*(3), 500-507.

President's Council of Advisors on Science and Technology. (2012). *Report to the president: Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics.* Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf

Spady, W. (1970). Dropouts from higher education: An interdisciplinary review and synthesis. *Interchange, 1*(1), 64-85.

Spady, W. (1971). Dropouts from higher education: Toward an empirical model. *Interchange, 2*(3), 38-52.

Swail, W. S. (1995). *A conceptual framework for student retention in science, engineering, and mathematics.* Dissertation conducted at the George Washington University, Washington, DC.

Swail, W. S. (2004). The art of student retention: A handbook for practitioners and administrators. *Educational Policy Institute*. Retrieved from http://files.eric.ed.gov/fulltext/ED485498.pdf

Swail, W. S., Redd, K. E., & Perna, L. W. (2003). Retaining minority student in higher education: A framework for success. *ASHE-ERIC Higher Education Report, 30*(2), p. i-62.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Education Research*, *45*(1), 438-4554.

Tinto, V. (1982). Limits of theory and practice in student attrition. *The Journal of Higher Education, 53*(6), 687-700.

U.S. Census Bureau. (2018). Poverty status in the last 12 month. *American Community Survey*. TableID: S1701. Retrieved from https://data.census.gov/cedsci/table?q=poverty%20level&hidePreview=false&tid=ACSST1Y2018.S1701&t=Poverty&vintage=2018

U.S. Department of Education, National Center for Education Statistics. (2015). *The condition of education 2015* (NCES 2015-144), *International Assessments*. Retrieved from https://nces.ed.gov/fastfacts/display.asp?id=1

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support*. American Educational Research Journal, 50*(5), 1081-1121.

Watkins, J. & Mazur, E. (2013). Retaining students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Science Teaching, 42(5),* 36-41

Whalen, D. F., & Shelley, M. C. (2010). Academic success for STEM and non-STEM majors. *Journal of STEM Education*, 11(1&2), 45-60.

Yelamarthi, K., & Mawasha, P. R. (2010). A scholarship model for student recruitment and retention in STEM disciplines. *Journal of STEM Education, 11*(5&6), 64-71.