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Lessons Applied and Best Practices through Peer Mentoring

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Abstract

This work will introduce methods that will aid in freshman retention (in the transition from high school and to remain in the university of origin) and orient them toward a successful career in STEM. Specific examples of successful approaches will be given as well as detailed plans for how to engage these students. Pitfalls as well as successes will be described. In addition, this work will address the needs of underrepresented populations, including women, ethnic minorities, and students from low socioeconomic status in the STEM fields, which at times have been referred to as "at risk" populations. This work will provide a detailed description of how to develop the students into a cohort that exhibits comradery. Three types of cohorts form—those within the freshman class, those among the upperclassmen, and those between the freshmen and upperclassmen. The program works because the social reality is that the peer mentor has a better repertoire with the first-semester freshmen than the faculty or staff and assists with student success. Factors such as financial aid, policy, and support systems influence student success. In the STEM-related courses, students often struggle with the content and adjusting to the college experience. Research states that a mentorship program supports retention as well as enhances the student experience during college. This program creates a cohort group among the upperclassmen mentors and freshmen and provides leadership development for all involved.

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Chapter 1
Issues in Higher Education and Science, Technology, Engineering, and Mathematics (STEM)

In the science, technology, engineering, and mathematics (STEM) fields, students often struggle with content while adjusting to the college experience, and underrepresented students often encounter additional challenges (Nelson, 2007; Martin, Stefl, Cain, & Pfirman, 2020; Leary, Morewood, & Bryner, 2020). Higher education institutions strive to help students experiencing these difficulties succeed and have positive educational experiences. Researchers find that supportive advising, culturally inclusive programming, mentoring, and strategic support systems can improve retention and enhance the student experience during college (Astin, 1993; Seidman, 2012; Castellanos & Jones, 2003; Kuh, Schneider, & Association of American Colleges and Universities, 2008; Renn & Arnold, 2003; Tinto, 1993; Nerio, Webber, MacLachlan, Lopatto, & Caplan, 2019, Leary, Morewood, & Bryner, 2020).

The design of the higher education system, though, hinders some groups from persisting through college (Walker & Dixon, 2002; Martin, Stefl, Cain, & Pfirman, 2020; Fries-Britt, & White-Lewis, 2020). Astin's (1984) development theory of student involvement recommends formulating effective retention policies because "the effectiveness of any educational practice is directly related to the capacity of that policy or practice to increase involvement" (p. 298). Effective policies enable students to have positive interactions with their campus environment and give administrators and faculty opportunities to help students achieve their personal and career goals and succeed in the STEM fields.

History and Purpose of Higher Education and the Evolution of the College Student

The first higher education institution in the United States in 1636, which was Harvard, supported the goal of educating the elite. Later, higher education is defined as a more formal system to support freedom and democracy (Dewey, 1916). This

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philosophy embraced access to higher education through the G.I. Bill of Rights, 1965 Higher Education Act, affirmative action programs, the establishment of more colleges during the 1970s, and the admission of more women during World War II (Gandara, Horn, and Orfield, 2005; Bogue & Aper, 2000). Although there was progress, the current system does not meet the need for postsecondary education" (Gandara et al, 2005; U.S. Government Publishing Office, 2020; Jungblut et al., 2018). The educational system faces the challenges of addressing the needs in STEM fields and handling the increasing numbers of students seeking access to higher education. Legal issues within higher education have attempted to address some of these challenges. The focus here is not the court cases within higher education, but seminal cases that provide a context for the current practices within higher educations.

Legal Issues in Higher Education

Legal issues arise from past practices in higher education. The Carnegie Commission in 1973 discussed controversies over practices concerning student access and academic success (Mayhew, 1973). Higher education began to be viewed as a beneficial investment and a framework for developing policies to increase access to higher education and a range of individual and societal benefits were recognized. Now educators considered who should benefit from higher education, who should pay, and provided a recommendation that one-third of the institution's cost to be covered by tuition. This information has been used to develop public policies to include the government, students, and taxpayers.

This funding distribution, however, continues to be influenced by court decisions forcing universities to evaluate their funding models and policies for students. Affirmative action and other issues related to student diversity and access to education also are impacted by court cases, such as the Supreme Court decisions in Grutter v. Bollinger (2003) and Gratz v. Bollinger (2003). These cases highlight the connection of racial and ethnic diversity in admissions to higher education. The plaintiffs in these two cases challenged the admissions policies of the University of Michigan Law School, which considered race in its admissions practices, and the Office of Undergraduate Admissions, which assigned points based on race and ethnicity. In June 2003, the Supreme Court decided that the law school's inclusion of diversity in its admissions policies was constitutional but deemed unconstitutional the Office of Undergraduate Admissions' practices that explicitly assigned points based on racial ethnicity. The court also ruled that state and federal funds for education access could not be allocated based on race or gender.

Since these and other rulings, universities have had to find different ways to expand access and funding to diversify student populations. In the *Harvard Business Review*, Bowen (1999) discuss changing trends in admissions and funding policies although race-sensitive admissions policies have existed for more than 30 years U.S. Government Publishing Office, 2020. Several reasons are discussed about why diversity should be valued, including that students of various races feel that diversity on campus and in the classroom enriches their college experience (Bowen, 1999). These and other policies influence who has access to higher education and the STEM fields.

Issues in Science Education

Concern has arisen over the United States' competitiveness in STEM fields. While the STEM definition proposed by Gonzalez, Kuenzi, the Congressional Research Service, and the Library of Congress (2012) includes science, technology, engineering, and math, although some employ broader definitions. For example, the National Science Foundation (NSF) includes psychology and the social sciences along with the core sciences and engineering (President's Council of Advisors on Science and Technology [PCAST], Washington, DC, 2012).

In contrast, others, such as the U.S. Department of Homeland Security and U.S. Immigration and Customs Enforcement, use narrower definitions, excluding the social sciences and focusing on mathematics, chemistry, physics, computer and information sciences, and engineering (PCAST, Washington, DC, 2012). While various government agencies administer STEM education programs, the following three account for four-fifths of federal STEM education activities: the NSF, the Department of Education, and the Department of Health and Human Services. This book will refer to science, technology, engineering, and math as representing the STEM field.

The PCAST report discusses areas of concerns in the STEM field, highlighting the racial and gender academic-achievement gaps in certain outcomes and challenges related to teacher quality in STEM education in kindergarten through 12th grade (K–12). Other concerns include international assessment rankings and the number of foreign students enrolled in STEM programs, of whom many return to their home countries. The report also notes issues in global STEM education, particularly the lower number of STEM degrees earned in the United States compared to other countries. The final area of concern is the lack of qualified individuals to enter the U.S. STEM labor supply.

This report discusses the need to address the achievement gap because, as some observers argue, underrepresented groups "embody a vastly underused resource and a lost opportunity for meeting our nation's technological needs" (PCAST, 2012, p. 23). Solutions include increased financial support for minority undergraduate STEM students, improvements to STEM teacher preparation, more offerings of advanced STEM courses, academic advising for minority K–12 students, increased transitional support to graduate school in STEM fields, and more minority research assistantships in STEM areas. These solutions can also help address concerns regarding women in STEM.

Due to changing trends among traditional college students, many students are unprepared to succeed in college, especially in STEM majors. Students struggle with introductory math and science courses, and STEM majors have low persistence rates (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013; Nerio, Webber, MacLachlan, Lopatto, & Caplan, 2019, Fries-Britt, & White-Lewis, 2020).

In 2012, President Barack Obama and the NSF, Labor Department, and American Council on Education launched a national initiative to improve STEM education and increase the number of job candidates prepared for STEM fields (Charleston, George, Jackson, Berhanu, & Amechi 2014). The program objectives included producing excellent STEM teachers and increasing the number of STEM degrees awarded.

The interactions between high school and college impacts STEM success. Although Maltese and Tai (2011) report that the number of bachelor's degrees earned has tripled over the past 40 years, this is not the case in STEM fields (Cutright, Evans, & Brantner, 2014). Accordingly, the NSF Committee on Science, Engineering, and Public Policy and the National Research Council (Charleston et al., 2014; Cutright et al., 2014) advocate for rigorous math and science curriculum in schools to prepare for the STEM workforce. These measures share the assumption that more students will work in STEM fields if they take more science and math classes. Sullins, Hernandez, and Fuller and Tashiro (1995) conclude that a significant predictor of student success is students' interest in staying in a particular STEM field (Martin, Stefl, Cain, & Pfirman, 2020) Positive experiences in high school science can motivate students to enter STEM areas in college, but once in college, students often leave the sciences due to negative experiences and a loss of interest in STEM courses. Other factors that impact success in STEM fields include finances, which affect both college persistence and time to degree completion (Ishitani, 2006; Fallon, et al., 2020). Individuals from various racial groups display attraction to STEM majors, so it might be important to increase interest in these areas among all student groups from kindergarten through college (Hilton & Lee, 1988; U.S. Government Publishing Office, 2020; Fallon, et al., 2020). Another factor influencing college students' success in STEM is the number of science classes completed in high school, which is positively associated with earning STEM degrees. Twelfth-grade students with an interest in STEM fields are three times more likely to earn STEM degrees than those planning to pursue different majors. Students who deeply desire STEM majors stay in those majors. College students who fail classes, change majors, or have children before degree completion tend to end up in non-STEM fields. However, students involved in work-study programs are no less likely to complete STEM degrees.

Framing the presentation of math and science material to make it more relevant to high school students' daily life could increase their desire to take STEM courses. STEM information should be personal, local, and relevant. For example, "rather than including chemical formulas for 'classic' reactions or discussing the effects of sea level rise on distant locals, [teachers should] focus the discussions on chemical processes in human digestion or environmental analysis of a local stream" (Maltese & Tai, 2011, p. 900). This approach to engage students by showing how science and mathematics are involved in their lives is reported to result in higher levels of interest than classes that do not emphasize these features (Maltese & Tai, 2011).

Moreover, when teachers highlight science careers, students are more interested in STEM areas. It, therefore, is concluded that a continued focus solely on achievement and enrollment in STEM majors is not sufficient to retain students in STEM fields. Instead, development, engagement, and encouragement of interest in STEM might be a better way to increase persistence in the STEM pipeline, which is the transition from high school to college and into the STEM workforce (Falloon, et al. 2020).

Scientific journals call for comprehensive changes in the educational structure to retain and graduate more students in STEM majors; U.S. Government representatives and other scientists have proposed recommendations to graduate students with STEM skills (Mervis, 2009a). It is important not only to support legislation regarding STEM education but also to implement processes to provide the finances, staff, faculty, and programs to carry out the legislation. For example, Xavier University, a historically Black college in Louisiana, has sought to improve its STEM curriculum since the 1970s and has continued this intervention into the present day. Xavier's continuous efforts have resulted in 62% of students enrolling in STEM majors and more African American students going to medical and dental school (Mervis, 2009b).

During the late 2000s, the declining economy caused many schools to cut their budgets and provide less support for STEM programs (Mervis, 2009c, 2013). Many students changed their college decisions based on the financial aid they received. Even in graduate STEM programs, the amount of financial support received by all students, including minorities, decreased. In 2010, only 51% of African Americans and 64% of Hispanics in STEM programs graduated debt free compared to 73% of Whites and Asians. Moreover, 27% of African American women—who are double minorities (women and racial group) in STEM fields—graduated with more than $30,000 in debt in contrast to only 10% of White and Asian women (Mervis, 2013).

These same issues impact graduate students in STEM education. Graduate students receive various types of support, which influence how much debt they accrue. Research assistantships often continue during the summer and provide funding for research that students use in their degrees, whereas teaching assistantships pay for efforts other than research and might not extend into the summer. These differences influence graduate students' needs for loans and lengthen the time it takes to degree completion. Mervis (2013) suggests that these disparities are affected by factors such as low socioeconomic status, family responsibilities, and lower institutional support (e.g., stipends and faculty grants). Training programs that recruit a diverse array of students may assist with some of these issues. These training programs include financial support to provide students relevant experiences in STEM-related settings. These resources assist with success in higher education.

Success is difficult in today's society without the training provided by higher education. Studies show that individuals with college degrees tend to earn more and live longer. For example, in 2008, the NSF launched a training program called the STEM Talent Expansion Program (STEP) to recruit, retain, and graduate more students into STEM fields. A notable research project by Bridgewater State University in 2010 received a $5.1-million STEP grant to implement a variety of programs in STEM pathways. The Student Retention Enhancement across Math and Science program led to simultaneous structural changes in all introductory science and mathematics courses. In addition, the university developed peer-led, cooperative-learning programs for courses, including first-semester introductory biology, calculus, and computer science classes and the first two semesters of chemistry and physics. These courses are recognized as tripping points when students often struggle or fail to enter the major. The exploration of these training programs and other factors impacting the STEM field provides a foundation for the discussion of issues in later chapters. This also suggests the importance of the STEM pipeline.

Arizona STEM Pipeline

Since our experience is from the State of Arizona our detailed understanding is for the State of Arizona in the United States. An issue in this STEM pipeline is challenges that arise from the K–12 and transition to the college level (Tawbush et al. 2020). This information is an important part of the STEM pipeline and the transition from one phase of the process into the STEM workforce. It is worthwhile to discuss issues related to underrepresented groups to better define the challenges within the STEM fields

It is important to understand the perspective of some underrepresented groups regarding STEM. The State of Black Arizona, Arizona Community Foundation, Arizona Public Service Company, & ASU Office of Public Affairs (2012) attitude survey supports five conclusions. First, being female has a positive relationship with pursuing STEM careers. Second, recent evidence indicates growing enrollment by African American women in STEM majors. Third, age has a positive relationship with pursuing STEM majors. Fourth, underrepresented groups often do not consider all vocational options equally; but when they do so, African Americans are more likely to choose STEM majors (State of Black Arizona, Arizona Community Foundation, Arizona Public Service Company, & ASU Office of Public Affairs, 2012). Fifth, when families support students' efforts to pursue STEM careers, African American students are more likely to succeed.

Addressing these issues leads to more underrepresented groups involved in the STEM field, which supports success for the STEM pipeline. Arizona's percentage is lower than the national percentages for STEM. For example Arizona's six-year graduation rate is significantly different from the national average. The state graduation rate for two-year institutions is higher than the national rate, 44% vs. 31%. The graduation rate for four-year institutions, however, is 56% nationally but 36% in Arizona. Among underrepresented student groups, it is 44% for Hispanics, 21% for African Americans, and 34% for American Indians in Arizona (F9, 2010; State of Black Arizona, Arizona Community Foundation, Arizona Public Service Company, & ASU Office of Public Affairs, 2012). On the National Assessment of Educational Progress science test, Hispanic and Black students score 50% lower than White students (National Center for Education Statistics, 2010a, b; State of Black Arizona, 2012).