Underrepresented Minority Students' Progression to Graduate School in Technology

E. Shirl Donaldson
The University of Texas at Tyler
sdonaldson@uttyler.edu

Kathryne A. Newton
Purdue University
kanewton@purdue.edu

Abstract

A phenomenological study was conducted examining the decision factors of underrepresented minority (URM) students' lack of plans for graduate school in the college of technology. Research conducted based on Systems Theory found that information, people, and organizations influence students (Berger, 2002)[1]. Comparisons were drawn about accuracy and access to information via the institution, research programs, outreach programs, various support systems, and personal networks. Fifteen subjects participated in semi-structured interviews. The researcher probed for in depth knowledge about the unique lived experience (Seidman, 1998)[2]. The present study fills a gap in technology education literature by examining undergraduates' perspectives concerning graduate school. An analysis of the factors that determine how underrepresented minority (URM) students decide to attend graduate school was important in highlighting processes, policies, and programs that should be implemented in the College of Technology to assist these students to obtain an advanced technical degree. The present research contributes to the growing body of literature in the field concerning attracting and retaining domestic URM students in technology, one of the fastest growing areas of STEM- Science, Technology, Engineering and mathematics with regard to need for trained professionals. This manuscript addresses three challenges; STEM education, job creation/workforce development and broader participation of underrepresented minorities.

Introduction

In the year 2010, 5863 students are awarded bachelor's degrees in technology across the United States. By 2013 that number had risen to 7,085. Technology or engineering technology, as some institutions label it, is the "T" in the acronym STEM. The number of undergraduate students receiving bachelor's degrees in technology is increasing every year. This trend is visible with underrepresented minority students as well. However the pattern changes when graduate school in technology becomes the focus. Every year at least 400 students complete technology degrees at Purdue University. In the year 2012 eleven percent, approximately 44 students, of these graduates were underrepresented minorities. Concurrently, there were 530 graduate students registered in the college of technology, however only seven percent were underrepresented minorities. One of the challenges in the United States is to alleviate the shortage of STEM professionals and educators and including URM's in the ranks (Clewell, de Cohen, Tsui, & Deterding, 2006)[3] and is one of the underlying motivating factors for this research.

> Since the 1980's there has been a steady increase in Bachelor's degree earned by URM students and in the 1990's there was a slight increase in STEM graduate degrees for URMs (Navarra-Madsen, et al., 2010)[4]. Since 2000 the numbers have flat lined (Navarra-Madsen, et al., 2010)[4].

As a volume leader in the number of bachelor's degrees awarded in technology in the United States, Purdue University's College of Technology (CoT) serves as a national role model to several peer institutions.

> American Society of Engineering Educators (ASEE) annually documents the number of graduates in engineering and engineering technology from Purdue University in its' statistical report. ASEE publishes the leading data on engineering colleges and engineering technology colleges in the United States including both individual college statistics and national trends.

https://www.asee.org/papers-and-publications/publications/college-profiles#Survey_of_Engineering_&_ET_Colleges [5]

Purdue is one of four Research I category institutions that have a college dedicated to technology (See Table 1). Technology majors, departments, schools, and colleges continue to define themselves in the academic realm (Kassel, 2005; Land, 2012)[6][7]. This area of study appears to be set between engineering, science, and business with numerous points of overlap. Subjects such as project management, supply chain management, and Enterprise Resource Planning (ERP) systems are taught in both management and technology. Computer programming is taught in computer science, engineering, and technology. As Diagram 1 shows, Purdue University's College of Technology is uniquely structured and supported as an integral part of a Research 1, land grant institution. Purdue's College of Technology's uniqueness and the underrepresented minority students who are educated within it present an opportunity for a phenomenological study such as suggested by Patton (2002)[8].

The United States has identified the lack of STEM educated professionals, broader participation and job creation as Grand Challenges.

> The White house press describes them as the following;
> "Grand Challenges are ambitious but achievable goals that harness science, technology, and innovation to solve important national or global problems and that have the potential to capture the public's imagination." Currently, the recognized 21st Century Grand Challenges are an element of the President's Strategy for American Innovation because they help catalyze breakthroughs that advance national priorities. On April 2, 2013, President Obama called on companies, research universities, foundations, and philanthropists to join him in identifying and pursuing the Grand Challenges of the 21st century.
> Grand Challenges Can:
> •Help create the industries and jobs of the future;
> •Expand the frontiers of human knowledge about ourselves and the world around us;
> •Help tackle important problems related to energy, health, education, the environment, national security, and global development; and
> •Serve as a "North Star" for collaboration between the public and private sectors [9]
> http://www.whitehouse.gov/sites/default/files/ostp_banner.jpg

According to the University Directory in the U.S. News and World Report, the number of positions in various employment fields that are now requiring a Master's level degree is increasing by 10.8 percent and major jumps are expected by the year 2018 (Groux, 2011)[10]. These facts present a need for more URM students to pursue Masters' and Doctorate degrees (Committee on Science, 2006)[11]. Increasing demand for more URM students with advanced degrees in technology is further justification for a better understanding of the factors that drive the graduate school decision (Stone, VanHorn & Zukin, 2012)

[12]. Nationally there is an obvious need for more people of color to pursue and obtain advanced degrees, especially in a STEM field (Committee on Science, 2006)[11]. A balance of timing, structure, and focus in the College of Technology (CoT), to support this has been created. Yet students perfectly positioned to take full advantage of the opportunity are choosing not to do so. Such a scenario presents a phenomenon that needs to be better understood by all of the concerned parties if the numbers of URM graduate students in technology are to increase in the future (Maton & Hrabowski, 2004) [13].

The AGEP program was developed in 1998 by the National Science Foundation (NSF) to facilitate the recruitment, retention, and advancement of underrepresented minority (URM) students in Science, Technology, Engineering, and Math (STEM) fields in the academe and the workforce (Patton, 2012) [8]. This statement represents the importance and need for resources that have been allocated to address the issue of the lack of URM students in the pipeline to graduate schools in STEM fields of study. Many scholars have explored barriers to completion in graduate education in STEM fields of study as a method to address the slim pipeline issue. The work typically discovered that the barriers vary within the STEM fields much like the subject matter and academic program structure.

According to (Groux, 2011)[10], more people are heading back to school to earn a master degree in pursuit of more career options and higher paychecks (Clewell, et al., 2006)[3]. Groux also reported that the Master's Degree has become the fastest growing credential in higher education (2011). Carol B. Lynch, director of professional master's programs at the Council of Graduate Schools stated that the master's degrees in subjects such as mathematics, engineering, science and technology seem to be driving this increase (Patton, 2012)[8]. Graduate education and wide spread domestic inclusion of domestic URM students in STEM fields is necessary to fully address several needs. From a broader perspective, challenges of job creation and national security are heavily dependent on the STEM fields; most notably technology for a sustainable solution (Committee on Science, 2006; Clewell at al., 2006)[10][3].

The purpose of this study was to gain a better understanding of how and why underrepresented minority students who major in technology make decisions about graduate school. The study seeks to find the details pertaining to the numbers that reflect stagnant enrollment rates for graduate studies after successful completion of undergraduate studies in technology. This research was designed to examine the lack of volume of URM students in graduate education in technology. One of the grand challenges in the United States is to alleviate the shortage of STEM professionals and educators (Clewell, de Cohen, Tsui, & Deterding, 2006) [3] and is one of the underlying motivating factors for the present research. The potential for increasing the number of URM graduate students is much greater at the entry point in the pipeline compared to the limited numbers of actual graduate students lost near the end of a program before completion. Simply stated, more students need to start graduate school in technology if more are to complete graduate school in technology (Navarra-Madsen, Bales, & Hynds, 2010).[4] Literature shows that minority students in cohorts or attending with critical mass tend to have higher levels of retention and completion than singular minority students in a predominately majority academic setting (Donelly & Jacoby, 2010)[13]. The positive effects of an inclusive community and a viable support network for URM students have been documented (Clewell, et al., 2006)[3].

Problem Statement

Many universities are closing the completion gap between minority and non-minority undergraduate students in STEM fields of study. The closing of this gap is producing more qualified URM students that are eligible to attend graduate school in technology. However a broader gap remains in the progression to graduate studies and completion of advanced degrees. The number of underrepresented minority (URM) graduate students is not sufficient to meet the need for URM faculty, researchers, practitioners and mentors in technology. How can this pipeline be increased and sustained? The present study investigated the career decisions of URM undergraduate students in the College of Technology at a large, uniquely structured Research level 1 university. Some of the academic peers according to the Carnegie Foundation include Washington State University, Georgia Tech, Colorado State, Iowa State and Texas A & M. What Factors Contribute to the Low Percentage of Underrepresented Minority Students Enrolling in the Graduate School in Technology at Purdue University?

Rationale: Gaps in Information about this phenomenon

According to Jessie DeAro, the AGEP program director at the NSF, "there is a definite gap in knowledge about URM students are not pursuing and completing graduate programs in STEM fields" (Patton, 2012)[14]. The Council of Graduate Schools is seeking information on which interventions have been beneficial to students involved in AGEP and similar programs. There is very little qualitative data available about why qualified student are not applying to graduate school (Patton, 2012)[14]. Federal agencies and universities are seeking this information. All of these factors are important to the researcher because the results may have broader impact in several ways (Seidman, 1998)[2]. Institutions of higher education such as Purdue University are interested along with the broader educational pipeline that feeds into universities. The issue researched in this study ultimately affects economic development, individuals, families, and communities**.**

Review of Literature

Academia and its supporting organizations, such the Chronicle of Higher Education, the American Educational Research Association (AERA), and the American Society of Engineering Educators (ASEE), provide additional and more detailed statistics (Donelly et. al, 2010)[13]. The trends are tracked and quantified in numerous categories by various characteristics such as gender, ethnicity, socio-economic status (SES), academic major, institution type, age, and geographical location. The literature review is yet challenging because of various definitions and use of the word "technology" and the different types of research surrounding it. For the purpose of the present study, specific definitions and scenarios will be considered within the academic scope of higher education. Such bounded scope by no means limits the vast impact that technology has on society, education, globalization, and individual lives. The researcher is respectful of the sector's growth yet needs to limit the discussion to a reasonable one.

The business dictionary website, defines technology as following:

> Technology is the purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities. Technology is generally divided into five categories (1) Tangible: blueprints, models, operating manuals, prototypes; (2) Intangible: consultancy, problem-solving, and training methods. (3) High: entirely or almost entirely automated and intelligent technology that manipulates ever finer matter and ever powerful forces; (4) Intermediate: semi-automated partially intelligent technology that manipulates refined matter and medium level forces, and (5) Low: labor-intensive technology that manipulates only coarse or gross matter and weaker forces [15].
> http://www.businessdictionary.com/definition/technology.html Retrieved June 14, 2012.

Technology majors, departments, schools, and colleges continue to define themselves in the academic realm (Kassel, 2005; Land, 2012) [6][7]. This area of study appears to be set between engineering, science, and business with numerous points of overlap. These references are critical as the discipline continues to grow and further define itself. Subjects such as project management, process improvement, supply chain management, and Enterprise Resource Planning (ERP) systems are taught in both management and technology. Computer programming is taught in computer science, engineering, and technology. Manufacturing systems, quality control, electronics, energy generation, product design and materials are all taught in technology and engineering. Purdue University is a unique institution because it has a College of Technology along with college of engineering, college of science and a school of business. Each college or school is an entity onto itself. In several peer institutions, technology is an academic major, department, or division of another school or college. Conversely there are other peer institutions that are only technical schools such as the Rochester Institute of Technology (RIT). As the following diagram shows, Purdue University's College of Technology is uniquely structured and supported as an integral part of a Research 1, land grant institution. Purdue's College of Technology's uniqueness and the underrepresented minority students who are educated within it present an opportunity for a phenomenological study such as suggested by Patton (2002) [8]. The following table, Table 1 Peer Institution Comparison, shows the uniqueness of Purdue University's College of Technology and its structure. The comparison was made to peer institutions based on the Carnegie classification filters of very high research activity and high undergraduate enrollment. See Table 1 below.

Peer Institution Carnegie Comparison Structure

Name	Technology	Col	Sch	Dept	Major	Minor	Entity
Arizona St.	X	X			X		
Colorado St.	X					X	Center of Science and Technology
Florida St.	X				X		Col. of Com & Information
Georgia St.	X				X		Col. of Education
Indiana Univ.	X			X	X		Kelly School of Business
Iowa St. Univ.	X			X	X		Col. of Engr
Mississippi St.	X				X		Col. of Agr & Boiology Engr
Oregon St. Univ.	X				X	X	Col. of Arg Sciences
Pennsylvania St.	X	X			X		
Purdue Univ.	X	X			X	X	
Rensselaer Poly.	X	X			X		
Rutgers Univ.	X				X		
SUNY at Albany	X			X			
Texas A&M	X				X		Dwight Look Col. of Engr.
Univ. Alabama	X				X		Dept. of Computer Science
Univ. Arizona	X				X		Col. of Science
Univ. Arkansas	X				X		Dept. of Agriculture & Extentsion Education
Univ. Cal-Davis	X				X		Col. of Letters & Science
Univ. Cal-SD	X			X			
Univ. Cal-SB	X			X			
Univ. Central Florida	X				X		Col. of Engr. & Computer Sc.
Univ. Delaware	X			X	X	X	Col. Agr. & Nat. Resources
Univ. Georgia	X				X		Col. of Agr. & Environmental Sciences
Univ. Houston	X			X	X	X	Dept. of Engr. Technology
Univ. Maryland	X			X	X		Col. of Agr. & Nat. resources
Univ. Massachusetts	X				X	X	Col. of Nat. Sciences
Univ. Missouri	X				X		Col. of Engr. & Computer Sc.
Univ. Nebraska	X				X		Col. of Agr. Sciences & Nat. Resources
Univ. New Mexico	X				X		Col. of Technology
Univ. Oklahoma	X				X		Dept. of the Hist of Science
Univ. Oregon	X					X	Dept. of Computer & Information Science
Virginia Common	X			X	X		
Virginia Poly.	X				X		Col of Agr & Life Sciences
Washington St. Univ.	X				X		Col of Agr, Human, & Nat Resource Sciences

Note. Undergrad; Engr= Engineering; Nat= Natural; Com= Communication; Arg= Agricultural; Col= College; Univ= University; Poly= Polytechnic; Hist= History; Sc= Science

Figure 1 Comparison of peer Institutions by Carnegie classification

The literature review in Land's 2010 study asserted that the industrial scope of technology has been evolving since the 1950s. Land paralleled the development and positioning of coursework at technical schools and universities to growth in industry stemming from the space race in the late 1950s. Certificate programs grew to degree granting courses of study. Two-year associate degree programs were expanded to four-year baccalaureate programs (Heiner, 1980)[16]. Heiner supported Land's position by stating that people create technology to solve problems however technology can create new problems as well. This creation of new problems drives the need for even more technologist to solve them in an effective manner. The dawn of the information age and growth of computer technology hosted the creation of several graduate degrees in technology in the early 1990s.

Programs designed to attract and retain URM graduate students. AGEP, PHD Project, SLOAN Foundation have found that there are several barriers to completion that include academic preparation for graduate studies, financial support, mentorship, research challenges, advisory committee conflicts and personal issues not related to graduate school. The PHD program found that the completion rates for doctoral students 35-55% overall. When these numbers are stratified by majors of study; they are 35% for STEM fields, 45% for Social sciences. The less than satisfactory completion rate limits the number of advance degreed technologist at a late stage in the process. Given the documented completion rates, more students must start the process or enter the pipeline to graduate degrees to ultimately produce an adequate number highly credentialed technologists and educators.

The numbers for enrollment or the attempts at advanced degrees are not increasing in proportion to the rate of completion for URM students or qualified potential applicants to graduate school. However, there was no available information or data about specific recruitment efforts of URM undergraduate students to apply to graduate school. The university employment placement center the Career Counseling Office conducts a brief survey of all graduating seniors as they complete the bachelor's degree. The survey focuses on employment status at the time of commencement. The question about graduate school is a simple "yes" or "no" inquiry without soliciting a reason for the decision. Demographics are not part of the exit survey.

Barriers to Entry and Perceived Barriers to Completions

According to (Schmidt, 2006) [17], there are barriers or obstacles to completion and persistence in the STEM fields of study at all levels. The present study seeks to identify the barriers for application and the initial pursuit of graduate school for underrepresented minority students in technology.

Methodology; Phenomenology

Phenomenological study describes the meaning of lived experiences of individuals in relation to a particular phenomenon (Denzin & Lincoln, 2003)[18]. Such a study illustrates a person's knowledge, perspective, and interpretation of personal experiences in a given context (Husserl, 1970) [19]. Phenomenology excludes what is outside of a person's truth and reality to derive experiences and perceptions that shape human situations. The method is unrestricted from preconceptions, hypotheses, and biases to describe "pure" phenomena (Husserl, 1970)[19].

Phenomenology was used to understand the factors that influence the discussions of undergraduate minority students' decisions in the College of Technology at Purdue University regarding whether to attend graduate school the STEM discipline of Technology. An explorative research design allowed the determinants of the 15 students' experiences to emerge from the data. According to Lester (1999)[20], "Phenomenological studies can indicate the presence of factors and their effects on individual cases, but they must be tentative in suggesting their extent to the population from which the participants or cases were drawn" (p.1).

Theoretical Framework - Systems Theory

Large organizations such as universities and colleges maybe viewed as complex systems. An individual's existence and experiences within these large organizations may be evaluated within the context of the systems theory. The Systems Framework is the underpinning theory chosen to explore this issue of URM students in technology. Patton (2002)[8] described the Systems Framework as the quest to answer the question "How and why does this system as a whole function as it does?" Lang & Carstensen (2002)[21] suggested that "Higher education as a whole is a system. Systems are self-protecting by design and produce a desired output. They are rooted in stability and not open to change". The theory stated that systems are assemblages of interconnected parts that often underlie complex technological and social structures (Bertalanffy, 1969)[22]. The properties of systems derive from interactions between its parts (Skyttner, 2005; Bertalanffy, 1969)[23][22][24]. According to Simon (1969), highly complex systems can be broken into subunits that are critical for its existence. Systems are composed of subsystems (Weick, 1976)[25] and subunits or elements that hold it together (Orton & Weick, 1990)[26]. The relationships permit an identifiable boundary between it and its environment (Laszlo & Krippner, 1998)[27]. Outcomes are modeled based on the interaction of units and the dynamics that define the characteristic functions, properties, and relationships internal or external to the system (Laszlo & Krippner, 1998, p. 48)[27]. Units that comprise the system are coupled to comprise the whole (Bertalanffy, 1969)[22]; however, each unit maintains its own identify (Weick, 1976)[25]. For example, academic departments, administrative units, and the university president's office are some of the parts that comprise a university system. These units work interdependently to achieve the goals of the system, primarily to educate students, disseminate knowledge, train people and produce research yet maintain their identity to provide services specific to its section. A failure or error in one part does not necessarily cause the whole system to fail.

Design of Study

Qualitative research was the most appropriate method for examining the present issue. It produces richer detail and provides insight into how and why a student's life experiences affect his or her decision-making processes to attend graduate school (Maton & Hrabowski, 2004)[12]. Quantitative methods such as frequency counts were used for the present study. Although quantitative methods provide data that shows the number of occurrences of a phenomenon, they

ISBN 978-1-60643-379-9

do not provide the richer detail necessary for explaining the reasons for the phenomenon. Responses were organized in categories from which research participants choose in quantitative research rather than allowing their responses to emerge from the data as in a qualitative study (Patton, 2002)[8].

Creswell 1998; 2007 [28][29] suggested 5 to 25 subjects and Morse (1994)[30] stated minimums of 6 subjects are required to conduct a phenomenological study. Therefore, the minimum number of 12 subjects was decided as a manageable amount that meets both criteria for a phenomenological study. Semi-structured interviews rather than ordinary surveys were conducted with each participant to probe for in depth knowledge about the unique lived experience leading to their individual decisions (Seidman, 1998)[2]. In this study, each student's experience reflects "truth about a composite picture of how people think about the institution [university] and each other" (Bogdan & Taylor, 1975, p. 11). The experiences of each student are different. "While people may act within the framework of an organization, it is the interpretation and not the organization that determines action" (Bogdan & Taylor, 1975, p.15)[31].

Population and Sample

Although the present research is not generalizable to a larger population, it is internally generalizable to the population examined (Maxwell, 1996)[32]. The subjects were selected by the stated criteria of junior or senior level URM students, the population was limited to Purdue University's main campus in the College of Technology. Purdue has an independent College of Technology that is not a department or attached unit to another school such as engineering, business or science within the university. For clarity and consistency in environmental or structural settings among the population, the sample was limited to Purdue University. Because of privacy regulations, there was no immediate access to students meeting the same criteria at peer institutions. Physical resources such as time, IRB approval, and finances prevented broader sampling from other universities at the time of this study. This is a criteria-based convenience sample. Participants were approached based on convenience, yet needed to meet three criteria to participate in the study (Patton, 2002)[8]. The criteria was the following:

- Must be a student in the college of technology
- Must self-identify as an underrepresented minority
- Must be have a student status of junior or senior level

Sample size

Fifteen students, representing ten percent of the upper level URM undergraduate student population, were interviewed. Creswell (1998)[28] suggested 5 to 25 subjects and Morse (1994)[30] stated a minimum of 6 subjects is necessary for a phenomenology study (Mason, 2010)[31].

These fifteen subjects had to meet all three criteria. It was determined that the subjects must be a junior level or higher because of the increased probability of the student remaining in the current program and completing the degree. Literature states that the third year is the pivotal point for many students especially minority students (ACE, 2006)[32].

Thirteen of the participants were Black. One participant was Hispanic. One participant self-identified as "mixed" or bi-racial of Black and White descent. There were no Native American participants. Figure 2 Demographics of the Participants shows the racial and gender composition of the participants.

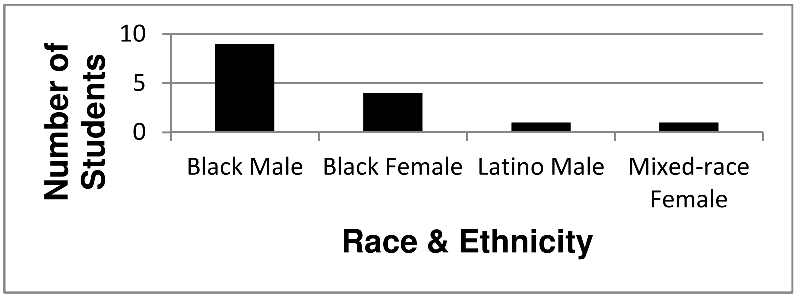


Figure 2 Demographics of the participants.

Data Collection & Analysis

A semi-structured, in-depth interview of each subject was conducted on an individual basis in a private setting. There were no panel discussions. One research assistant was in the room with the interviewer to help record data. The in-depth interview process is the core of a phenomenological study method (Seidman, 1998)[2]. The interviews consisted of several open-ended questions that allowed for deeper probing by follow-up questions based on the subject's response (Creswell, 2007; Groenewald, 2004)[28][32]. Such an interviewing style provided flexibility to address various topics as they were presented during the dialogue. Along with the traditional manual coding, Nvivo software was implemented for automated data and structure analysis (Patton, 2002)[8]. Transcriptions of each interview were coded by the software and reviewed by the researcher. "Key words", "key phrases", and "redundant terms" were identified for further analysis.

Majors of Participants shows that six of the eight departments in the College of Technology were represented in Figure 3. The fact that there were departments in the college that were not represented may limit the generalizability of this study. This is always a risk with convenient sampling (Patton, 2002)[8]

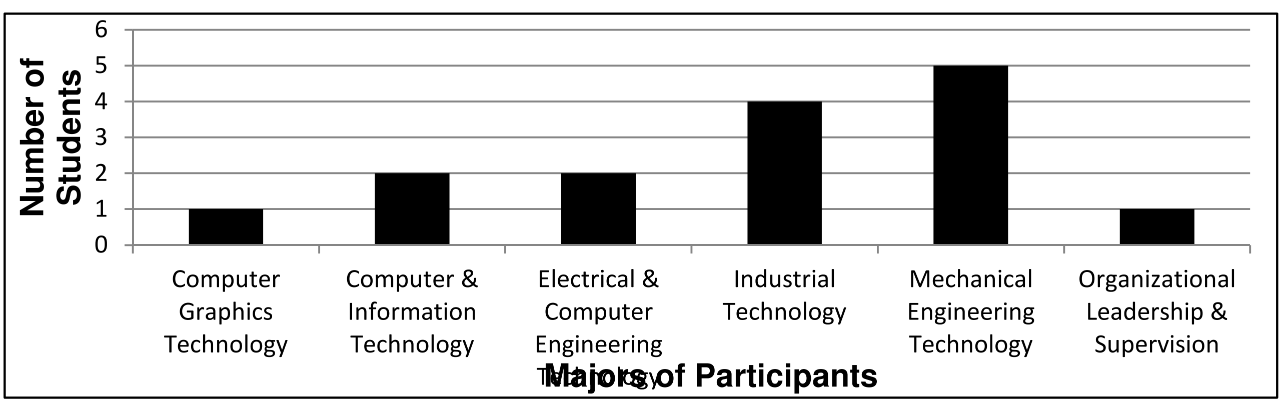


Figure 3. Majors of Participants

1. Are you planning to attend graduate school? Why or why not?

"I need to pay off loans."
"I need financial aid."
"I need more knowledge."
"I did not prepare."
"I am tired of school."
"I might get an MBA."
"I don't need it in my major."
"It costs too much."
"I don't want to do research."

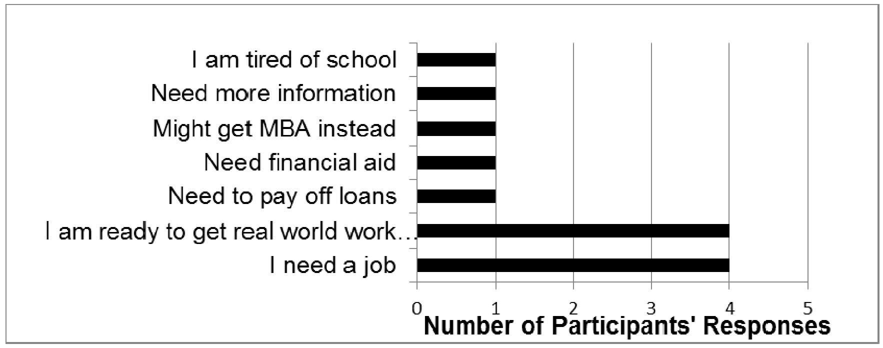


Figure 4 Reasons for Not Attending Graduate School

9. What are your career plans for after graduation?
"I am going to work in my field."
"I am still looking for a job. I might go to graduate school if I don't find one."
"I might get a MBA."
"I might get a Master's later if my job will pay for it."
"I might go back to school if I have too in order to get promoted."

10. Do you have any student loan debt?
Only four of the 15 participants said that they did not have student loans. The other eleven participants said they have loans, with amounts ranging from $5,000 to $100,000. One participant stated that he had student loans but was not sure how much because his parents were handling them. Figure 5 shows a summary of the participants' students' loan debt.

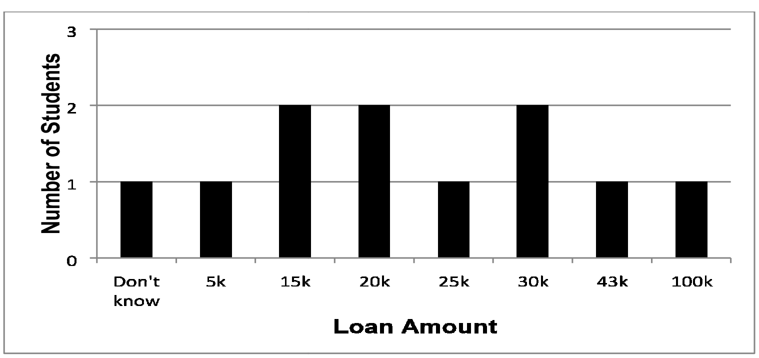


Figure 4.5 Participants student loan debt

Figure 5 Participants'' Student Loan Amounts

FINDINGS

Three major themes emerged from the present study. The themes were financial constraints, lack of preparation and lack of information concerning graduate school. Each one of these themes had sub themes that yielded more details about the students' lived experiences.

ISBN 978-1-60643-379-9

First major finding: Financial Constraints

Finances: these students expressed the need to secure a job and payoff student loans. In tandem, these students were adamant about not wanting to incur any additional debt for graduate school. Financial constraints extended to concerns regarding funding for graduate studies. The participants expressed specific concerns about how they could afford to attend graduate school unless a future employer sponsored them. Only one participant mentioned having funding available for graduate studies.

Three-fourths of the participants interviewed had student loan debt incurred during undergraduate studies. Most were not interested in accruing more debt for graduate school.

Most of the participants stated they were ready to go make some money. They needed real income and work experience. It was evident that their primary goal throughout their undergraduate programs was to get a job with regular income. The focus was on internships, Capstone courses, and creating portfolios to impress potential employers during the interview process.

All participants indicated they needed funding. Most of them were seeking funding from future employers. They displayed little faith in university support. The need for fellowships and information concerning available fellowships was clear. In one instance, a participant was asked about changing his decision about graduate school. The following exchange occurred:

Second major finding: Lack of Preparation

Lack of academic preparation was the second emergent theme among the reasons for not attending graduate school. Participants displayed apprehension concerning the standards for acceptance. Some students even stated that their grades did not reflect their true knowledge or ability. Their grades were often reflective of their personal circumstance. Three of the participants stated they did not have the GPA to be admitted to a graduate program. One of these three participants also stated that this low GPA probably would prohibit obtaining a fellowship or other competitive funding. Two of the three stated they were not considering graduate school earlier in their academic career and were less concerned about their GPAs than they were presently. They thought that their GPAs would be high enough to graduate and get a job.

Several participants were not prepared to take the GRE. Four participants did not know what the GRE was. Two participants stated that they did not like standardized testing, so the test was to be avoided. One subject told the interviewer that he had a friend who failed the GRE. Note: There may have been an extremely low score but there is no passing or failing status available. None of the participants displayed a true understanding of the application process. The response given about career plans and job searches were evidence of this lack of knowledge.

Third major finding: Lack of information

Most of the subjects had very little detailed and accurate information about graduate school. The subject that only received information from friends and family were classic examples of the strong ties and loose coupling theories. The students were more involved with highly structured campus organizations had better details about graduate school, research and funding possibilities.

Twelve subjects lacked knowledge concerning the value of graduate school as further credentialing for increased competiveness in the job market. Most stated that work experience was being sought by employers and set as a priority. There was no apparent knowledge about the marketability of research skills. Six of the participants viewed research as tedious work in a lab. There was a lack of understanding concerning the broad range of potential research areas that would match numerous types of interests and skill sets.

Five of the subjects reported that friends or relatives suggested that they go to graduate school while they were young and before they got married. In contrast, just as many reported being advised to wait and let their future employers pay for their advanced degrees. Ten of the subjects had no knowledge about the application or funding processes. Also they did not appear to understand the time required to apply and receive acceptance into a graduate program.

Participants who had the most accurate information about graduate school were LSAMP scholars. Four out of the 15 subjects had participated in undergraduate research sponsored by LSAMP. These scholars had a working relationship with graduate or faculty mentors. The subject quoted plans to go to graduate school after gaining some work experience. His response about whom or what influenced his decision follows:

"I would say my professor who I been doing research with and been mentoring me. Professor X, and my mother were the two main influences. Along with this program, I've been on campus called LSAMP. They have had a couple of panels and forums and people would come and speak to us about grad school and so I would say that they have been a really big influence as well. It gave me a window to look and see how grad school is structured and how to get money, fellowships, and everything like that."

Most of the students not affiliated with LSAMP did not have an adequate understanding of graduate school or its' benefits. Nor did these students appreciate the value of research. Many of the students did not understand the value of research or the value of developing research skills. They did not know why they might need research skills later. It required several follow up questions to get to the participants' real feelings about research and lack of understanding. Such lack of knowledge was apparent when some of the participants spoke of future plans and potential time lines. The emphasis on job readiness and lack focus on graduate school were indicated by the following segment of an interview.

So you are planning on going to work, well so you are looking?
"Yeah the plan right now is to look for a job and I'm saying if I can't find a job in 3 to 5 months… then I would actually consider coming back to grad school or actually maybe attending grad school … But I am giving myself that time frame."
So you are going to start looking after graduation, are you saying during your last few semesters that you didn't actively look?

"I did actively look. The problem was the work load; everything was conflicting. I had several tests and exams, I had projects going, and part of my one of my course was to actively look for a job and I was actually looking for a job. I have several companies that do want me. The problem is that the whole point of the interview is that you have to sell yourself in that hour that you have or whatever you have with them. And my problem was that like I said that I was too occupied with a lot of worrying about graduating, stress about the classes, tests projects, and other stuff that I had going on and then having to worry about flying out to different states for 2 days to interview with them and I just didn't have enough time to actually prepare myself for the interviews.

This participant stated that he would go to graduate school if he did not find a job in three to five months. He is using graduate school as an "option plan" or a "safety net". Yet he made no efforts to discover the application process. If this were truly his strategy, he needed to be applying for jobs, graduate school, and fellowships simultaneously. Based on his current strategy and timeline, if he were to decide to go to graduate school in three to five months, applied, and he was accepted, he would not enroll until the following year, the spring or fall of the next. By taking this approach, a delay of a year is the outcome if he is accepted.

Discussion of work experience and employer requirements was prevalent amongst several participants. The idea of company sponsored or paid graduate programs usually accompanied the idea of the required for promotion. The need for immediate employment is a common reason for not preparing for or planning to go to graduate school. The immediate plan for obtaining employment is evidence of being socialized for work and feeling financial pressure from the cost of undergraduate studies.

Discussion

The present study fills a gap in technology literature by examining a targeted sector of undergraduates' perspectives about graduate school. An analysis of the factors that determine how URM students decide to attend graduate school is important for highlighting processes, policies, and programs that could be implemented to assist these students in obtaining an advanced degree. This research contributes to the literature in the field concerning attracting and retaining domestic URM students in graduate school in technology. There are several factors that influence whether or not undergraduate minority students obtain a degree in a STEM discipline. As evidenced in the present research, most of the undergraduate participants interviewed in this study had no intention to enter a graduate program in technology. Many were socialized for work, while others had substantial loan debt that influenced their decision to go to work.

Suggestions being made are based upon the findings in the present study and supported by relevant literature to benefit all stakeholders. These suggestions are not criticisms of the current policies or practices, but an opportunity for alignment of programs and practices to meet the stated goals for the future.

Summary of Findings

Major findings were discussed in terms of students' experiences and the effect on career choices with respect to graduate school in technology. Students were uninformed about graduate school. Accuracy and important details were lacking from their overall understanding. Students were unprepared for graduate school academically, socially, and financially. These three major issues should be addressed in several separate initiatives for change to occur.

Participants in the study were eager to go to work rather than continue their education for financial reasons. Most of them did not have real knowledge of the benefit of graduate school and they did not understand the value of developing research skills. Some of the subjects in the present study are considering a MBA, if they return for an advanced degree. This delayed return would be determined by employer recommendation and financial support and a diversion from a STEM field of study. The vast majority of participants in the study indicated that they did not apply to graduate school immediately because that they wanted/needed to get a job. Several students echoed the emphasis on earning a sizable income and gaining work experience.

Most of the participants received information about graduate school from friends and teaching assistants informally. Often this casually gained information was incomplete or inaccurate. This relates to the loose coupling theory. According to Weick (1976)[25], organizations can be considered as information environments where people receive and share relevant information and data. Organizations can be viewed as systems of information.

The present research found that faculty and administrators concentrate more on preparing students for an industry focused career in technology or applied engineering. It is understood that career preparation has been the stated goal of the college. However, this practice has unintended consequences that result in lack of attention given to educating and preparing students to attend graduate school. Bowles and Gintis (1976, 2002)[36] found that universities in the United States socialize students for a career in the workforce, often based on the needs of a capitalistic society. The research supports their finding concerning student socialization towards work. This was evidenced further by the emphasis on employment and job readiness in the majors that feature a capstone course. These capstone courses issued no credit for preparation for or application to graduate school only for job interviews.

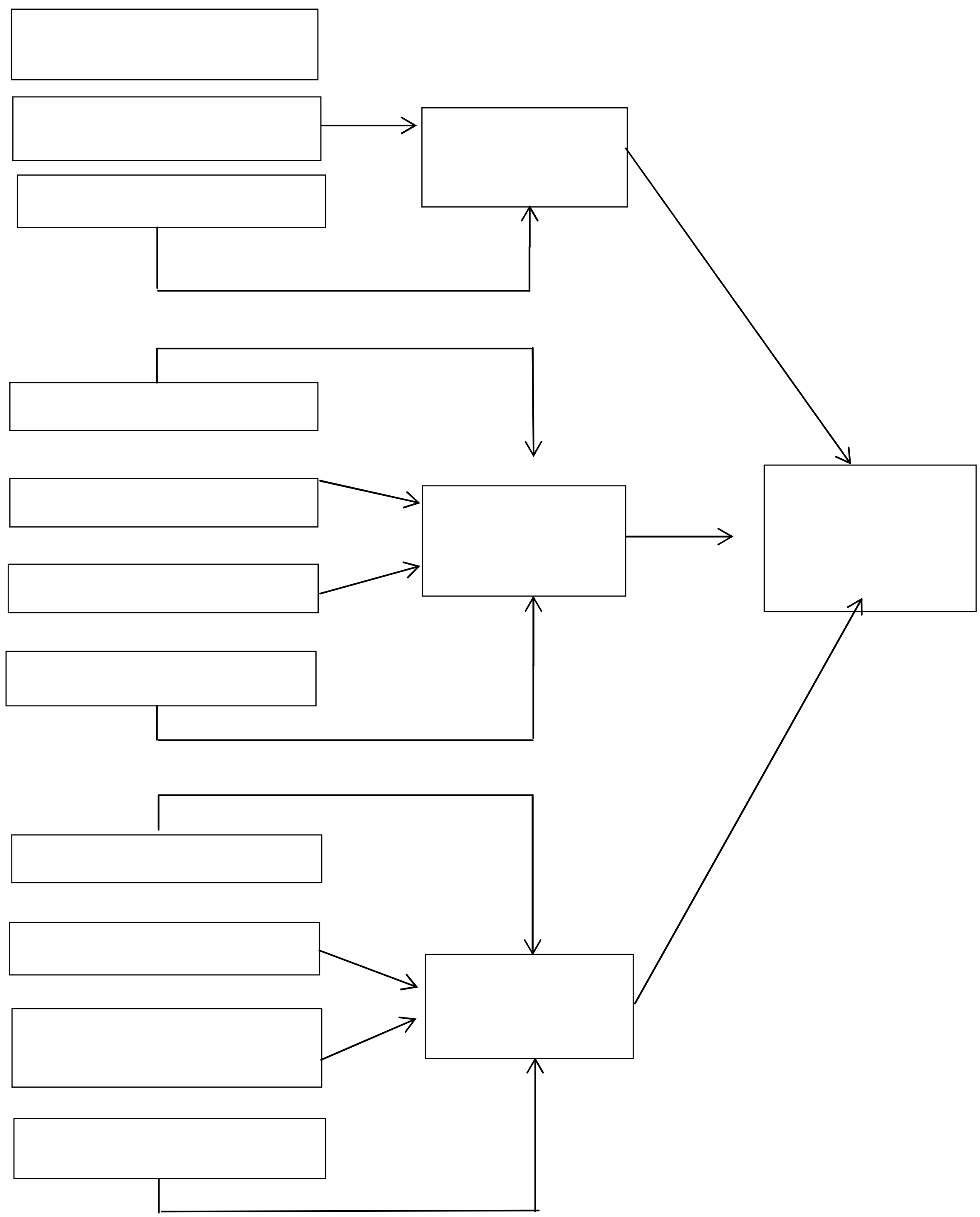
The students who received the most accurate information about graduate school received it from Louis Stokes Alliance for Minority Participation (LSAMP) and had participated in undergraduate research. The second most common source of accurate information was professors in class. Unfortunately, very few subjects reported having formal mentors. The participants with the most inaccurate information received it from friends and their teaching assistants in class. The uninformed students had no mentors and did not experience research as an undergraduate. Involvement in student organizations such as Minority Technology Association (MTA) and National Society of Black Engineers (NSBE) seemed to have minimum impact with awareness about graduate school.

Implications

Students need accurate information about the value of research, graduate school, and long-term career planning throughout their undergraduate studies. Students would benefit from financial

ISBN 978-1-60643-379-9

advice, especially regarding managing loan debt. Timing, academic preparation, and recognition of opportunity must be prioritized for students and professors each semester. Preparation needs to occur throughout the undergraduate program. Starting this process at the end of one's senior year is too late. These factors and the implications are depicted in Figure 6



ISBN 978-1-60643-379-9

Figure 6 Model of Factors Influencing URM Students in Technology Decision to Attend Graduate School. Note: The factors leading to a decision against attending graduate school were outputs from the present research.

Recommendations - Addressing Each of the Findings from the Research Questions

1. Is fear of the initial transition to graduate school or adjusting to the institution preventing students from applying (Myers & Pavel, 2011)[33]?

None of the participants mentioned any fears about adjusting to the institution or the college.

2. Is the fear of taking GRE or the impact of low scores a determinant for not applying to graduate school (FairTest, 2007)[38]?

Several participant listed the GRE as a contributing factor for not applying to graduate school. None of the participants had plans to attempt the GRE. Debate is often heated about whether or not it should be required for admittance to graduate school. The GRE has been charged with being biased and not a true predictor of success especially for minority students. Students need to understand how the complete application package is evaluated by the graduate admissions committee. The accusation of bias against minorities speaks to a difference in backgrounds and life experiences. This difference in life experience is a form of preparation for competition. To offset some of the biases in the GRE, preparation is critical. The recommendation is that undergraduate students be encouraged to start preparing for the exam as early as sophomore and juniors years. This will allow time to retake the exam if necessary. Obtaining an acceptable score early allows students to apply to graduate school and for funding earlier. Early application is often critical for securing funding on a competitive basis.

3. Could the cost of attendance be viewed as prohibitive by students, especially, when compounded with debt from undergraduate studies?

Definitely. Funding is the most critical issue to be resolved. Students must be made aware of funding options other than loans leading to further indebtedness. This is not just an issue of cost or value but also a sign of priority and inclusion. If the college or the university supports students of every other nationality more than URM students, a message is sent about a lack of importance or value. This issue can be addressed by allocating specific funding to achieve the strategic goal of supporting URM graduate students by departments within the College. Assistance with applying for outside funding also should be provided to students involved in targeted fundable research areas.

4. Do students view the opportunity cost and additional time in school too expensive in a competitive job market (Horn et. al, 2012)[35]?

Financial concerns were the highest priority with the participants. These students need to manage and minimize debt from undergraduate studies if they are to seriously consider graduate school immediately after completing undergraduate programs. Additional scholarships for URM students should be established.

Table 2 - Primary Source of Support for Doctorate Recipients

Support	US Citizens	Temporary Visa Holders
Teaching Assistantships	15%	22%
Research Assistantships	23%	50%
Fellowships/Grants	11%	21%
Own Resources	24%	4%
Employer	5%	1%
Other	0%	3%

Council of Graduate Schools (2012)[42]

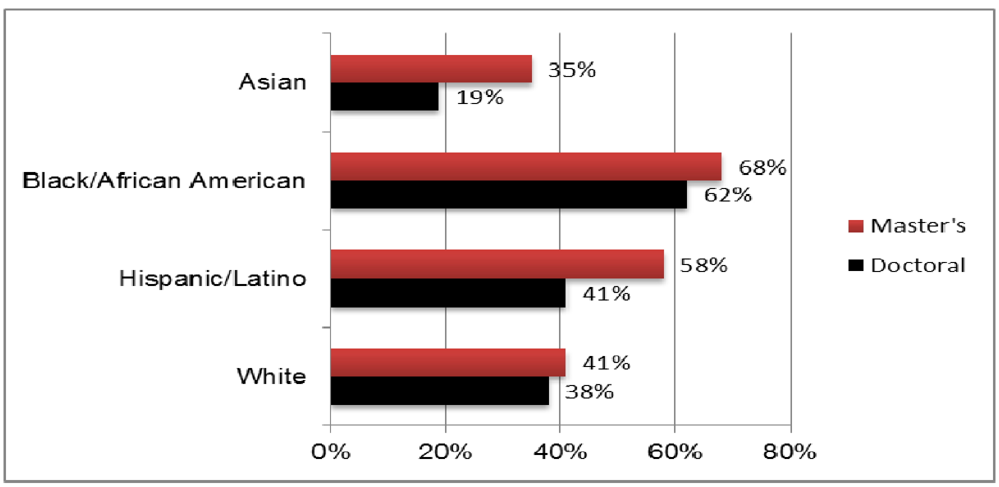


Figure 7 Borrowing and Race/Ethnicity Percentage of Graduate Students with Loans by Level & Race/Ethnicity 2007-08. Council of Graduate Schools (2012)[42]

5. Does the amount of debt from undergraduate school dictate that students focus on immediate repayment rather than advanced degrees and deferred payment (Stone et. al, 2012)[11]?

Undoubtedly debt from undergraduate studies influences all career decisions for this population according to this study. To further address the mounting debt from undergraduate studies, along with increased scholarships, many of these students would benefit from book stipends and additional financial support.

6. What are the student perceptions about graduate school that elude faculty and administrators (Searle, 1983)[41]?

Many students have a narrow view of research. Providing students with a real undergraduate research experience will give them a sense of the types of projects available in their area of interest and worthy of funding (Boyer Commission, 1998)[43]. The data obtained by this research showed that many students are unaware of how much that they do not know. Faculty and administrators may assume that students know more than they do because information is prevalent in a university setting. Yet many students do not know which question ask or to whom. Mentorship is critical for student development and progression to graduate school. Information about the immediate and long-term value of graduate school in career planning is essential. As stated in the Boyer report (1998)[43], research intensive universities need to get students started valuing research from the start of their undergraduate programs.

Figure 8 - Model of Factors of Preparing URM Students for Graduate School suggests that providing the elements that were found to be lacking in the undergraduate experience of the participants in the present study might garner a different result. According to the Boyer Commission (1998)[43], the university ecosystem as a whole needs to change its approach to course work and undergraduate research. The Counsel of Graduate Schools (2012)[42] stated that more funding is needed to support URM students in the STEM fields of study.

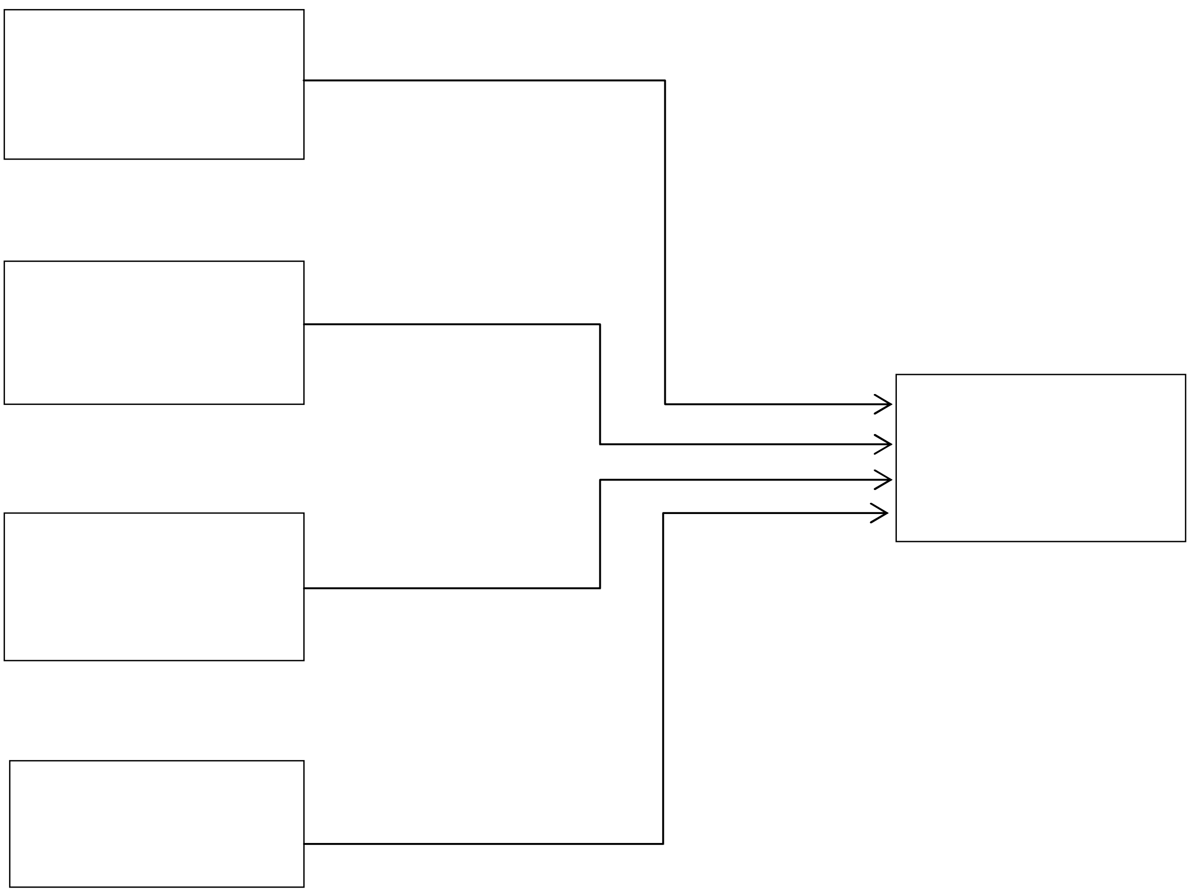


Figure 8 Model of Factors to Prepare URM Students for Graduate School

This model suggests providing the factors found lacking will better prepare students for graduate school possibly leading to an increase in application and attendance

Recommendations for Further Research

Obviously the research would be enhanced significantly by examining a larger sample from several peer institutions. Extending this research to examine minority undergraduate populations who major in technology at other research universities in the United States may be beneficial. The new knowledge is critical for understanding how to increase the STEM pipeline.

The major strength of the present study is its internal generalizability. The findings and conclusions of the study are generalizable to the phenomenon and group studied (Maxwell, 1996)[32]. Its strength lies in the fact that it is an extreme case that can contribute to theory about the specific area examined, such as "identifying the determinants for URM students applying to graduate school". It's value lies in the ability to extract findings and conclusions about the group or setting examined (Maxwell, 1996, p. 97)[32]. The types of processes that consequently caused this phenomenon of qualified URMs who are not applying to graduate school in technology are likely to exist at other universities. The comparison of this finding with similar studies will have useful contributions to the technology field.

If a similar study were to be conducted in the future, participants should be asked about their total time until completion. The long-term effects of going to summer school an additional year or two should be investigated. The actual time and financial resources needed to complete a bachelor's degree in a STEM field is often longer than in non-STEM disciplines (Hutson, 2009)[44]. Therefore, academic fatigue and additional financial burdens and related consequences should be explored. URM students from peer institutions in technology should be interviewed similarly and compared if the opportunity is presented.

Summary

The present research contributes to the technology literature about the influences acting on URM student's progression to graduate school. Most of the participants stated that they would return to school later for a MBA. This statement has based on information from friends or potential employers. Only a few participants stated a desire for an advanced degree in technology. Nationally there is more funding available for advanced degrees in STEM fields of study versus advanced degrees in business. Students need to understand why this funding exists and how to access it. Most important, the research shows how financial support and accurate information influence student priorities and decision-making about career preparation. Students must be informed about all potential financial assistance, fellowships, and assistantships. Such lack of information can have devastating effects on the attraction of future potential URM graduate students in technology.

References

[1] Berger, J. B. (2002). The influence of the organizational structures of college and universities on college student learning. Peabody Journal of Education, 77 (3), 40-59. New York, NY: George Braziller, Inc.

[2] Seidman, I. (1998). Interviewing as qualitative research, A guide for researchers in education and the social sciences. New York: Teacher College Press.

[3] Clewell, B., de Cohen, C, Tsui, L., & Deterding, N. (2006). Revitalizing the nations talent pool in STEM. Washington DC: The Urban Institute.

[4] Navarra-Madsen, J., Bales, R. A., & Hynds, D. L. (2010). Role of scholarships in Improving success rates of undergraduate science, technology, engineering and mathematics (STEM) Majors. Procedia - Social and Behavioral Sciences, 8, 458-464. doi: 10.1016/j.sbspro.2010.12.063.

[5] American Society of Engineering Educators (ASEE) . Papers and Publications- College Profiles- Survey of Engineering and ET colleges. 2012. https://www.asee.org/papers-and-publications/publications/college-profiles#Survey_of_Engineering_&_ET_Colleges

[6] Kassel, B. (2005). Paul DeVore; A new Industrial-Arts Curriculum for the Post-Industrial Era. Oswego.Nov. 2005

[7] Land, R. E. (2012). Engineering technologists are engineers. Journal of Engineering Technology (Spring 2012), 7.

[8] Patton, M. Q. (2002). Qualitative research and evaluation methods Thousand Oaks: Sage.

[9] Whitehouse.Gov./sites/

[10] Groux, C. (2011). Master's degrees become the fastest-growing credential. U.S. News University Directory.com.Retrieved May 20, 2012

[11] Stone, C., Van Horn, C.,& Zukin, C. (2012). Chasing the American Dream: Recent College Graduates and the Great Recession WorkTrends; Americans Attitudes about work, employers and government. New Brunswick: Rutgers University.

[12] Maton, K. I., & Hrabowski, F. A. (2004). Increasing the number of African American Ph.D.s in the sciences and engineering: A Strengths-based approach. American Psychologist, 59 (6), 547-556.

[13] Donelly, A. E., & Jacobi, J. (2010). Attracting, retaining, and preparing a diverse academic engineering workforce; The AGEP model for success. IEEE Educon Education Engineering, Madrid Spain.

[14] Patton, S. (2012). 21 colleges win grants to study what helps minority Ph.D. students in sciences succeed. The Chronicle of Higher Education.

[15] Bell, T. (2012). Counsel of Graduate Schools: Graduate student funding and support. NAGAP Winter Institute

[16] Heiner, C, Hendrix, W. (1980). People create technology. Worchester: Davis Publications

[17] Schmidt, P. (2006). Study blames obstacles, not lack of interest, for shortage of Black and Hispanic scientist. The Chronicle of Higher Education. April 2006.

[18] Denzin, N. K., & Lincoln, Y. S. (2003). Introduction: The discipline and practice of qualitative research. In N. K. Denzin, & Lincoln, Y. S. (Ed.), Strategies of qualitative inquiry. (pp. 1-45). Thousand Oaks: Sage.

[19] Husserl, E. (1970). The crisis of European science and transcendental phenomenology. Chicago: Northwestern University press.

[20] Lester, S. (1999). An Introduction to phenomenological research. Tauton.

[21] Lang, F. R. & Carstensen, L. L. (2002). Time counts: Future time perspective, goals, and social relationships. Psychology And Aging, 17(1), 125-139. Doi:10.1037/0882-7974.17.1.125

[22] Bertalanffy, L. V. (1969). General systems theory: Foundations, development, and applications.

[23] Skyttner, L. (2005). General systems theory: Problems, perspectives, practice. Rivers Edge, NJ: World Scientific.

[24] Simon, H.A. (1969). The architecture of complexity. Proceedings of the American philosophical society, 106 (6), 467-482.

[25] Weick, K. E. (1976). Educational organizations as loosely coupled systems. Administrative Science Quarterly, 21, 19.

[26] Orton, J. D., & Weick, K. E. (1990). Loosely coupled systems: A reconceptualization. Academy of Management Review, 15(2), 203-223.

[27] Laszlo, A., & Krippner, S. (1998). Systems theories: Their origins, foundations, and development. Systems theories and a priori aspects of perception (pp. 47-74). Amsterdam: Elsevier Science.

[28] Creswell, J.W. (1998). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Thousand Oaks: Sage Publications

[29] Creswell, J. W. (2007). Qualitative Inquiry & Research Design; Choosing Among Five Approaches. Thousand Oaks: Sage Publications.

[30] Morse, J.M. (1994). Critical issues in qualitative research methods. Thousand Oaks, CA Sage Publications.

ISBN 978-1-60643-379-9

[31] Mason, M. (2010). Sample size and saturation in Ph.D. studies using qualitative interviews. Forum: Qualitative Social Research, 11 (3), 15.

[32] Maxwell, J. A. (1996). Qualitative research design: An interactive approach. Thousand Oaks, CA. Sage.

[33] Business Dictionary (2011)http://www.businessdictionary.com/definition/technology.html

[34] ACE, (2006). Increasing the graduation rates of minority students in STEM Fields By the Numbers; A digest of higher education data. Washington DC: American Council on Education.

[35] Bogdan, R., & Taylor, S. J. (1975). Introduction to qualitative research methods. New York: Wiley.

[36] Groenewald, T. (2004). A phenomenological research design illustrated. International Journal of Qualitative methods, 3 (1).

[37] Myers, C. B., & Pavel, D. M. (2011). Underrepresented minority students in STEM: The transition from undergraduate to graduate programs. Journal of Diversity in Higher Education, 4 (2), 90-105. doi: 10.1037/a0021679

[38] FairTest (2007). Examining the GRE; Myths, misuses and alternatives (pp. 2): National Center for Fair and Open Testing.

[39] Horn, L., Zahn, L., Carroll, C.& Dennis. R. (2012). From bachelor's degree to work; major; Field study and employment outcomes of 1992-1993 Bachelor's degree recipients who did not enroll in graduate education by 1997. Washington DC: edpubs.

[40] Bowles, S & Gintis, H.(1976) Schooling in capitalist America: Educational reform and the contradictions of economic life. The Journal of Human Resources, Vol. 12, No. 2 (Spring, 1977), pp. 275-277 Published by: University of Wisconsin Press Article Stable URL: http://www.jstor.org/stable/145392.

[41] Searle, J. R. (1983). Intentionality; An essay in the philosophy of mind. Cambridge: Cambridge University Press.

[42] Council of Graduate Schools (2012).Trends in students aid. http://www.cgsnet.org/data-sources-graduate-student-loans-and-debt-0

[43] Boyer Commission (1998). Reinventing undergraduate education: A blueprint for America's research universities. Carnegie Foundation for the Advancement of Teaching, Princeton, NJ.

[44] Hutson, B. (2009). Moving the numbers. Black Enterprise, Vol 3.

[45] Bowles, S. & Gintis, H. (2002) The inheritance of inequality The Journal of Economic Perspectives Vol. 16, No. 3 (Summer, 2002), pp. 3-30 American Economic Association Stable URL: http://www.jstor.org/stable/321.

Biographies

Dr. Donaldson is an Assistant Professor at the University of Texas at Tyler in the College of Business and Technology. She teaches technology courses and provides faculty mentorship on industry sponsored projects. Professor Donaldson is a certified project management professional (PMP). A strong advocate of inclusionary practices in education and business, Dr. Donaldson encourages students to work to their strengths while constantly expanding their skill sets and prospective of life. In 2015 Dr. Donaldson was selected to become an Entrepreneurial Leadership Academy Fellow. The Entrepreneurial Leadership Academy is a resource support program for faculty who have entrepreneurial interests. sdonladson@uttyler.edu

Dr. Kathy Newton is the Associate Dean for Graduate Programs for the Purdue Polytechnic Institute and a Professor of Supply Chain Management Technology at Purdue University. Her teaching and scholarly interests are in the areas of supply chain management technology, graduate education and quality. She recently completed a 3-year appointment as Department Head. Prior to her appointment at Purdue University in 1993, she spent seven years teaching for Texas A&M University's Department of Engineering Technology and Industrial Distribution. Dr. Newton has a Ph.D. in Educational Human Resource Development, a Master's degree in Business Administration, and a B.S. in Industrial Distribution, each from Texas A&M University. kanewton@purdue.edu

ISBN 978-1-60643-379-9