Fall 2020
Volume 11, Issue 2

From Research Technician to Graduate Professional Student

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Abstract

The future of our economy will require workers with backgrounds and understanding of science, technology, engineering, and mathematics (STEM). Current STEM degreed people are a valuable source that should be utilized to meet growing demands to advance the U.S. economic and scientific agenda. Biomedical research centers employ a substantial number of college graduates with STEM degrees that gain technical skills that will enable them to pursue specialized training for careers in medicine, research, and other technology industries. Most who seek jobs as research technicians hope to receive some guidance on how to gain successful admission to graduate and professional programs. We hypothesize is that Research Technicians are a viable group to consider developing training programs to help address the shortage of workers with advanced degrees within the US STEM workforce. A cross-sectional survey was used to generate background and descriptive data on participants' interests and intentions. Once collected, the data were analyzed using descriptive analysis and thematic development methods. Of the 299 technicians, 117 responded to the survey, and 57% indicated they sought employment to gain admission into BCM graduate/medical schools. This study provides evidence that Research Technicians (RTs) are a viable group to consider developing intentional training programs to help address the shortage of workers in the biomedical sciences.

Introduction

The future of our economy requires workers with diverse backgrounds and expertise in science, technology, engineering, and mathematics (STEM). The National Science Board (2015) indicates that the STEM workforce is critical to the nation because of its role in fostering innovation,

economic competitiveness, and national security. The Georgetown University Center on Education and the Workforce (2014) reported that the demand for workers in STEM occupations is increasing at every educational level. For decades, we have had a shortage of women and minorities in biomedical STEM fields; these groups are also underrepresented when it comes to obtaining doctorates (2015 NSF report). U.S. is also faced with a significant shortage of medical doctors to serve the rapid increase in the retirement population caused by baby boomers (AAMC 2016 update). STEM industries need strategies to increase the biomedical workforce because the current pool is not sufficient to replace the aging workforce (NSF 2014). The 2012 President's Council of Advisors on Science and Technology (PCAST) and the 2012 National Research Council report discussed strategies to adequately prepare U.S. citizens with STEM skills and knowledge. When implementing these educational strategies, it is equally important to identify strategies that leverage the talents of current workers with STEM degrees. These people are a valuable source of skills and expertise that should be utilized to advance the U.S. economic and scientific agenda.

Biomedical research centers employ a substantial number of college graduates with STEM degrees. We define biomedical research centers as academic research institutions that grant M.D. and Ph.D. degrees. These institutions also employ a diverse research staff. Research Assistants, Research Coordinators, Research Technicians are all part of the STEM biomedical workforce. These employees gain valuable skills that will enable them to pursue specialized training for careers in biomedical research or clinical fields, as well as many other industries. There is a commonly-held belief among colleagues at various biomedical research centers that research technicians seek employment at these sites because they want to enter graduate or medical school at these institutions. For example, a subset of faculty interviewed at Baylor College of Medicine, Purdue University, University of Texas Health Science Center-San Antonio, University of Massachusetts, and Washington University-St. Louis, firmly believed that technicians were there primarily for one purpose – to gain admission into the professional programs. Many faculty advise their college graduates to seek employment at these institutions, believing that these students who may not have been successful in prior attempts at gaining admission would gain skills that make them stronger applicants. These students are told to stay in the biomedical environment to encourage them to stay focused on their career goals. Of course, most students may not consult with their faculty advisor and deduce that this is a logical path for admission on their own. Some of these employees might expect that by merely working in the institution, they are given an edge over other applicants and, therefore, will be able to advance to the next career level. Many recent college graduates, especially under-represented minorities, decide to pursue these careers late in their undergraduate training. They recognize the need for additional experience before submitting applications to these programs. Research technicians are pursuing this pathway on their own. Determining the motivations of this group is likely to be helpful in better supporting their goals.

In this study, we draw upon Social Cognitive Career Theory (SCCT) as a theoretical framework. SCCT builds on the career interest of many of the cognitive theories that were "developed to address the role of background variables, self-efficacy and outcome expectations in the development of vocational interest, professional career choice and work performance "(Lent & Brown, 2006; 2013). When drawing on career interest expectations of SCCT, we suggest that through professional activities and guidance from mentors, Research Technicians can refine their skills, develop career and academic standards, and increase their self-efficacy to acquire the knowledge needed to pursue advanced degrees. More specifically, Research Technicians will more than likely enhance their interest in the biomedical sciences by engaging in activities, such as seminars and information sessions, and developing skills which they view as essential to pursue a terminal degree. These activities, along with the decision to apply to graduate programs, result in what Lent, Brown, and Hackett (1994; 2000), consider a positive outcome for academic and career interest development.

It is important to note that while professional experiences in the lab foster academic interests, it can be theorized that self-evaluation also plays a significant role in academic development. Once interest crystalizes, research technicians seek the necessary steps to pursue an advanced degree in biomedical sciences, thereby creating a positive outcome for themselves and the biomedical workforce.

Professional choice is affected by the learning experiences associated with professional development that may occur in work environments and structured settings. Bocanegra, Gubi, and Cappaert (2016) examined the learning experiences, self-efficacy, and choice intentions to enter a psychology graduate program. They found a significant relationship between exposure and choice intention to pursue graduate studies. Given the challenges faced in the biomedical sciences workforce, SCCT can be useful to explain how steps taken by Research Technicians to expand their knowledge in career-relevant activities affect choice and influences their academic and professional choice to pursue advanced academic training.

The guidance of a mentor can strongly influence academic choice. Xu's (2013) investigation of college students in STEM majors found that faculty accessibility and academic guidance increased the likelihood of degree completion. Mentoring is an effective way to prepare undergraduate research students for graduate school (Laursen et al., 2010). A recent study determined that mentors can have a lasting effect on the career path of graduate students and postdocs (Woolston, 2019). Woolston (2019) found that joining the lab of a prolific mentor also increases a scientist's chance of success. To this end, the NIH has funded the National Research Mentoring Network (NRMN) in which mentor training and materials are provided to implement process-based mentoring. NRMN provides mentors with guidance and structure for technicians, trainees, and scientists working in the lab. Scholars have posited that formal and informal mentoring relationships are closely tied to the future success of research of trainees (de Janasz and Sullivan, 2004; Curtin, Malley and Stewart, 2016). Eby et al. (2013) reported that trainees

with strong mentoring support are more successful than those without mentor assistance. These variables tend to have predictive power when determining academic and professional choice. Consequently, if training programs at academic research institutions are to address the talent gap in the biomedical sciences, they must identify alternative strategies to recruit, develop, and mentor future trainees.

Methods

We hypothesize that Research Technicians are a viable group to consider developing intentional training programs to help address the shortage of workers in the biomedical sciences. The immediate goal of this exploratory study was to identify the interests, skills, knowledge, and abilities of a specific group of employees, Research Technicians (RTs) at Baylor College of Medicine (BCM). We utilized SCCT to evaluate the academic and professional choices of RTs ' interest in pursuing an advanced degree in the biomedical sciences. Additionally, this study explains the relationship between academic and professional choice and pursuing a terminal degree (dependent variable) among RTs in the biomedical sciences. Specifically, we seek to ascertain the predictability of academic and professional choice (independent variables) on pursuing a degree beyond the bachelor's and pursuing entrance to a Ph.D. or M.D. program.

Research Questions. *Research Question 1*: To what extent do survey responses indicate that a substantive sized pool of RTs interested in earning a Ph.D. or M.D. already exists at biomedical research centers? *Research Question 2*: Do academic and professional choice variables have any predictive power of RTs 'interest in pursuing entrance into a Ph.D. or M.D. program?

Study Population. *Participants: In 2011, d*ata collected from BCM's Human Resources show that 299 research technicians were employed at BCM. All research technicians employed at Baylor College of Medicine were eligible to participate in this study. RTs employed at BCM are typically classified in one of three categories. We targeted RT I, II, or III employees who worked in biomedical research laboratories. These three employee titles require at a minimum some research experience, but a bachelor's degree is preferred.

Survey Design and Instrumentation. To conduct this study, the Institutional Review Board (IRB) for Human Subject Research for Baylor College of Medicine and Affiliated Hospitals (BCM IRB) approved H-28383. A cross-sectional survey was administered (Rivera and Murray, 2014) to collect academic and professional choice data, as well as demographic data from the study participants. We modified the Human Genome Sequencing Center's (HGSC) Minority Diversity Initiative's (MDI) program evaluation survey (H 15405, Exempt from IRB review) for this study. (The lead author of this study created the HGSC-DI survey for an earlier publication for a similar population.) The majority of the HGSC-DI survey items addressed the experiences of the study technicians to give a comprehensive picture of this population. We converted the paper form of the MDI survey into an electronic form using SurveyMonkey® to host 30 survey questions for

distribution. After we collected the self-reported data, stored the responses, Human Resources representatives provided email addresses of the research technicians working at BCM in 2011 (with approval from the V.P. of Human Resources). Invitations to participate in the study were sent to all email addresses included in the list. The invitation explained the study's purpose and that the survey would be anonymous and voluntary. Four separate reminders were sent across the 6-week data collection period to boost response rates. We provided a workshop for medical school admission to all study participants as an incentive to participate in the study once completed.

Demographic information such as gender, age, and race/ethnicity was collected to ascertain the educational backgrounds such as high school setting, post-secondary educational choices, and classification in undergraduate study (if still in school) or if trained beyond the bachelor's degree. We asked survey respondents if they were first-generation college students. Section II asked specific questions regarding family demographics. Section III questions were formulated to understand the respondents 'perspectives concerning professional progress, for example, on future degrees of interest, laboratory experiences, and understanding of the institutional environment.

Data Analysis. Data were analyzed in collaboration with Strategic Evaluations, Inc. (Durham, NC). All descriptive data tables and statistical tests were performed using *SPSS v21* (IBM, New York, NY) to compute descriptive statistics, as well as test for correlations and statistical significance. Qualitative data submitted for open-ended questionnaire responses were analyzed via *Atlas.ti* (Berlin, Germany) to assign thematic codes to research technicians 'narrative comments.

A correlational research design, along with a binary logistic regression, was used to examine the extent to which selected academic and professional choice variables can predict interest in pursuing a terminal degree. For the logistic regression, the dependent variable was measured in a dichotomous format defined by research technicians 'terminal degree outcome code with the dummy value: 1 = *Research Technicians interested in obtaining a Ph.D. or M.D.*, or 0 = for *Research Technicians who are not interested*. The predictor variables "professional choice" were defined by RTs 'choice to work at the institution in order to gain admission to a terminal degree program, participation in scientific workshops, participation in informational seminars to gain admission into a terminal degree program, and attendance at departmental seminars as a means of developing skills, knowledge and abilities for future careers in the academic medicine. We defined RTs receiving guidance regarding the admissions process and mentoring as the predictor variables for "academic choice." The cluster of survey items that constituted these broader variables was coded using the same binary values, "0" for 'no 'responses and "1" for 'yes 'responses.

Occupational Information Network (O*NET). We used STEM competencies defined by Carnevale, Smith, and Melton (2011). They isolated competencies specific for different occupations using the National O*NET Consortium's database to measure the importance of various competencies within an occupation. The O*NET data allowed them to quantify competencies unique to STEM. O*NET has information on occupational knowledge, skills, abilities, work values, and work interests, as well as key performances (tasks and activities) for 965 different occupations (https://www.doleta.gov/programs/onet/). The database contains hundreds of standardized and occupation-specific descriptors on almost 1,000 occupations covering the entire U.S. economy (www.onetcenter.org). Using O*NET, Carnevale et al. (2011) identified the cognitive (Knowledge, Skills, and Abilities) and noncognitive (work values and work interests) competencies most highly correlated with STEM occupations. STEM Knowledge is the most occupation-specific competency with ten knowledge domains (e.g., mathematics knowledge, computers, and electronics). STEM has a core set of cognitive skills; Critical Thinking, Active Learning, Complex Problem Solving, and Science are a few examples of this competency. STEM Ability is associated with the capacity to utilize knowledge learned to solve problems. The two abilities used most often in STEM are Mathematical Reasoning and Deductive Reasoning.

Results

BCM Employees: Survey Respondents. Baylor College of Medicine (BCM) has provided medical and research training for over 75 years in the state of Texas. BCM is the highest ranked medical school in Texas as well as in the Southwest region and is one of the top schools in the nation. It is ranked 16th among research-intensive medical schools, and number 5 in primary care medical schools according to the 2018 U.S. News & World Report annual list of top graduate schools (ranked 22nd in 2011). Nationally, the Graduate School of Biomedical Sciences (GSBS) ranks 26th in the biological sciences, and the Baylor Physician Assistant program ranks 13th. The nurse anesthetist doctoral program ranks 2nd among all masters/doctorate nurse anesthesia programs in the country. At most biomedical research institutions, M.D. and Ph.D. degree-granting organizations, there are several job titles associated with laboratory research training. We targeted the Research Technician employee designation because this group has degree requirements necessary to obtain a doctorate or medical degree. In 2011, a total of 299 research technicians were employed at Baylor College of Medicine, 71% were female, and 27% were male (data collected from BCM Human Resources). Research Technicians employed at BCM are typically classified in one of three categories: Research Tech I, II, or III. At the time of this study, this pool of employees had the following make-up: 39 Research Tech I, 148 Research Tech II, and 112 Research Tech III.

The degree requirements and work experience differ for each technician category. Research Technician I's have prior work experience and some college or an associate degree. While Research Technician II's have bachelor's degrees, they are not required to have prior research experience. At a minimum, Research Technician III's have bachelor's degrees, but these requirements favor someone with a master's and one year of research experience. Institutions

around the country have similar job titles, classified as Research Technician, or Research Assistant, or Researcher.[1] At BCM, employees have the opportunity to advance within these positions, from I to III, through examples of proven leadership and demonstrated skills and abilities. A Research Technician I can demonstrate management and organizational skills when taking the lead in ordering supplies, updating protocols and approvals (IRB, animal), and maintenance skills when keeping instruments repaired to keep the lab functional. Research Technician II's can take the initiative to lead by maintaining the equipment, laboratory stocks and common areas, communicating with biotech salespeople, ensuring accurate record keeping, compiling and analyzing data, assisting in preparing laboratory reports, and organizing general lab regulations. Research Technician III's can demonstrate project management skills to lead a study that would include the independent design of research experiments, write technical reports, troubleshoot and solve critical problems, display expertise in methods and techniques, and engage with outside collaborators.

The 299 research technicians received the survey via email. In all, 120 technicians responded to the survey request, constituting a response rate of 40%. The employee's status was self-reported by each study participant. Table 1 shows that the largest group of technicians that answered the survey were Research Tech II's (49%). Research Technician III's represented 32% of the study respondents, and 29% of respondents indicated they were classified as Research Technician I's.

The mean age of survey respondents was 29 ±8.9 with the range in age being 21 to 64 years old. The most significant number of survey responses came from female technicians, (64%), and this corresponded to the HR data that showed females made up the largest proportion (72%) of the technician population. The majority of the technicians were U.S. citizens/permanent residents (roughly 69%) with 30% identifying as non-U.S. citizens.

To document how this group identified racially/ethnically, we further disaggregated the ethnicity categories provided by HR. The technicians self-reported their race and/or ethnicity. Based on their responses, the study population was composed of the following: Asian 40%, African American 7%, Caucasian 31%, and Hispanic 15%. Several other ethnicities were represented but at smaller proportions – Fijan (1%), Tongan (1%), and multiracial (3%).

[1] A few examples of institutions with similar job descriptions and qualifications, include: Duke University, Research Technician I (associate's degree), and Research Technician II (bachelor's degree); University of Texas Health Science Center at San Antonio, Research Assistant (bachelor's degree), Senior Research Assistant (bachelor's degree + 2 years 'experience) , Research Associate (bachelor's degree + 4 years 'experience); and Washington University at St. Louis, Research Technician I (high school diploma), Research Technician II (bachelor's degree), Senior Research Technician (master's degree).

Table 1: Demographics for Research Technicians.
N = number of technicians submitting responses

Gender	**N**	**Percent**
Female	76	64%
Male	41	35%
No Gender Provided	1	1%
Citizenry		
Non-US Citizen	35	30%
US Citizen/Permanent Resident	81	69%
No Citizenry Data Provided	2	2%
Race/Ethnicity		
Asian	47	40%
Caucasian	36	31%
URM	30	26%
African American/Black	8	7%
American Indian/Alaska Native	0	0%
Filipino	4	3%
Other Pacific Islander (Fijan,Tongan)	1	1%
Hispanic-No Race Provided	17	15%
Multiracial	3	3%
No Race/Ethnicity Provided	2	2%
Job Title		
Research Technician I	34	29%
Research Technician II	56	49%
Research Technician III	38	32%
Missing	2	2%
Age (n=114)	Mean = 29 ± 8.9 yrs Median = 25 yrs Min= 21 yrs; Max=64 yrs	

Technicians 'Development of Science Competencies. *Knowledge*. Science competencies are gained in Knowledge, Skills, and Abilities with demonstrated proficiency in each area (Carnevale et al., 2011). Knowledge classifications have content domains familiar to educators (Carnevale et al., 2011). Traditional course work for STEM majors increases content knowledge, a science competency. Biology, Chemistry, Mathematics, Physics can define Knowledge competence. Knowledge is necessary to develop Skills and Abilities. Specific levels of education (associate's degree vs. master's degree; Chemistry I vs. Analytical Chemistry) can often indicate a marked gain in knowledge, and earning a degree in a STEM field signifies an increase in Knowledge Science competency (Carnevale et al., 2011). Each technician identified the level of education they had obtained at the time of the survey (Table 2). The following education levels were available for selection: high school (9-12) junior college or two-year associate degree; four-

year college: B.A., B.S.; graduate school – M.A., M.S.; Ph.D.; or other. These data helped to determine the educational levels the study participants had achieved and also provided a perspective on their science competency. The majority of the respondents, 70%, held B.S. or B.A. degrees. Several had higher degrees such as master's (15%), M.D. (4%) and Ph.D. (<1%). Many technicians were continuing their education (data not shown). A few were university seniors (3%), in master's degree programs (7%), or community college (4%). Some reported continuing education activities such as taking additional post-baccalaureate classes or studying for the United States Medical Licensing Examination (USMLE), and one was granted admission into medical school.

Table 2: Education and Work Experience for Research Technicians.
N = number of technicians submitting responses

Highest Degree Earned	**N**	**Percent**
High School	1	<1%
Associates (2-year degree)	3	3%
Bachelor's	83	70%
Master's	18	15%
Ph.D.	1	<1%
M.D.	4	4%
Missing	8	7%
Years on the Job		
Less than 1 year	34	29%
1 to 3 years	51	43%
Greater than 3 years	22	19%
Missing	11	9%

*Percents may add to more than 100% due to rounding to the nearest whole number.

Typically, a recent college graduate will need one or two years to prepare and advance to the next career level. The timeframe utilized develops an increase in science competencies; these skills assist with career focus. The length of employment could indicate seriousness toward preparation for an advanced degree program. The employee in the position longer may have difficulties with professional school development activities and remain on the job longer. A considerable number of technicians reported that they worked at BCM between 1-3 years (43%). Twenty-nine percent had worked at the institution for less than one year.

Faculty at various biomedical research centers suggest that a considerable proportion of Research Technicians (RTs) seek employment at institutions similar to BCM to gain entry into Ph.D. or M.D. programs. To determine the extent to which these observations were true, we asked, "*If you are interested in a Ph.D. or M.D., did you seek employment at BCM with plans to gain admission into these programs?"*. The majority (57%) of the technicians responded "yes", indicating that they did seek employment at BCM with the intention of gaining admission into

BCM graduate or medical school (Figure 1). Although a large number of RTs answered "yes", it was unknown which terminal degree they were interested in pursuing. To determine RT degree aspirations, participates were asked to indicate their interest in pursuing a Ph.D., M.D., master's, or teaching certificate. Thirty-seven percent of participants had an interest in pursuing a Ph.D., while 44% were interested in earning an M.D.

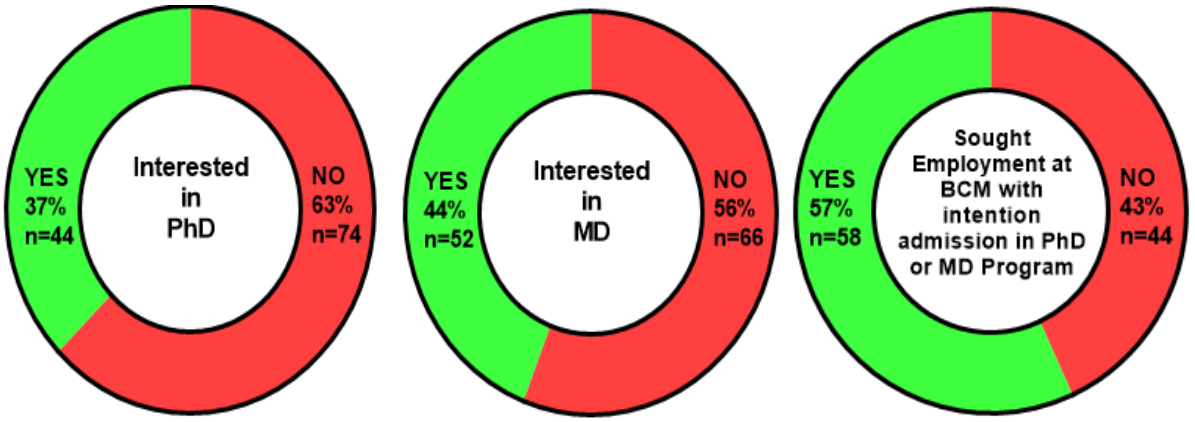

Figure 1. Research Technicians' Terminal Degree Interests and Intentions for BCM Employment. Survey responses were collected to understand RTs' terminal degree intention. Survey items presented in the middle of each graph. "Parts of whole" graphs were created using GraphPad Prism version 7.03 for Windows, GraphPad Software, La Jolla California USA, www.graphpad.com, displaying the proportion of 'yes' and 'no' responses. 'Yes', responses denoted by green, 'no' responses denoted by red. The survey respondents indicated 57% sought employment intending to gain admission in a terminal degree program, and 37% of the RTs were interested in a Ph.D. and 44% M.D.. N=number of RTs responses

Research institutions such as BCM may give more consideration to doctoral program applicants with prior research experience along with GPAs. Therefore, in attempting to keep the survey burden low, we did not capture the RTs 'GPAs from the survey. The Graduate Record Examination (GRE) is a requirement for many graduate programs. It is often considered to be an assessment of an applicant's critical thinking, analytical writing, verbal reasoning, and quantitative reasoning skills. The highest possible score for both the Quantitative and Verbal sections is 800. According to Staffroni (2016), students taking the exam scoring 680 had an average 52% percentile on the Quantitative section of the exam. Using the same report, students that averaged 50% on the Verbal section scored 460. We asked the technicians if they had taken the GRE. Across the entire sample of RT respondents, a significant number (37%) had taken the GRE. Many had taken the exam before the GRE had changed the format (Table 3). The scores ranged from 680-800 Q (Quantitative) and 540-570 V (Verbal).

Table 3: Graduate and Medical School Admission Exams.
N = number of technicians

Has Taken GRE Exam (n=100)	N	Percent
No	63	63%
Yes	37	37%
GRE Performance Ranges (n=20)	Quantitative 680 - 800 Verbal 540 - 570	
Has Taken MCAT Exam (n=99)	N	Percent
No	78	79%
Yes	21	21%
MCAT Performance Range (n=18)	Lowest = 15 Highest = 36	

When considering an applicant for medical schools, a substantial number of programs use holistic review (AAMC, 2015). Academic metrics like GPA and Medical College Admission Test (MCAT), letters of recommendation, and personal statements that show a wide variety of clinical and leadership experiences among other data are considered to indicate a measure of "academic preparation."[2]

Interestingly, fewer technicians (21%) had taken the MCAT than those that had taken the GRE (Table 3). This study occurred before the MCAT changed in 2015. The lowest MCAT score self-reported by the technicians was 15, and the highest was 36. In 2010, the average MCAT score for students at allopathic medical schools was 31 (AAMC). At the time this study was conducted, BCM accepted applicants with scores of 38 and above.

Skills. Another area of science competency, Skills, can be determined by many factors (Carnevale et al., 2011). Any activity that increases active learning, critical thinking, reasoning, and applying knowledge can be considered contributors to science competency skills (Carnevale et al., 2011). Skills are developed capacities that facilitate learning or the more rapid acquisition of knowledge (O*NET). Skills are competencies developed in the context of particular knowledge

[2] The GPA and MCAT are usually the focus of an applicant's undergraduate and post-baccalaureate preparation. Research experience is required for M.D./Ph.D. applicants, but not for M.D. only, however, the benefits of research training (increase critical thinking skills, forming and investigating hypotheses, perseverance) can enhance M.D. only applications (AAMC, 2015).

classifications that allow continued learning in a knowledge domain (content, processing, and problem-solving skills). The research technician position is designed to train employees at biomedical institutions in specific areas according to the biomedical research focus of the laboratory. This research training provided by these laboratories increases the employees 'skill level and in turn, can make them more competitive for terminal degree programs. RTs who participated in the study were asked, "*Is your current employment teaching you skills that will be useful for your professional development?*" The RTs overwhelmingly responded "yes" with 86% indicating confidence in technical training that was beneficial to the next career level (Figure 2).

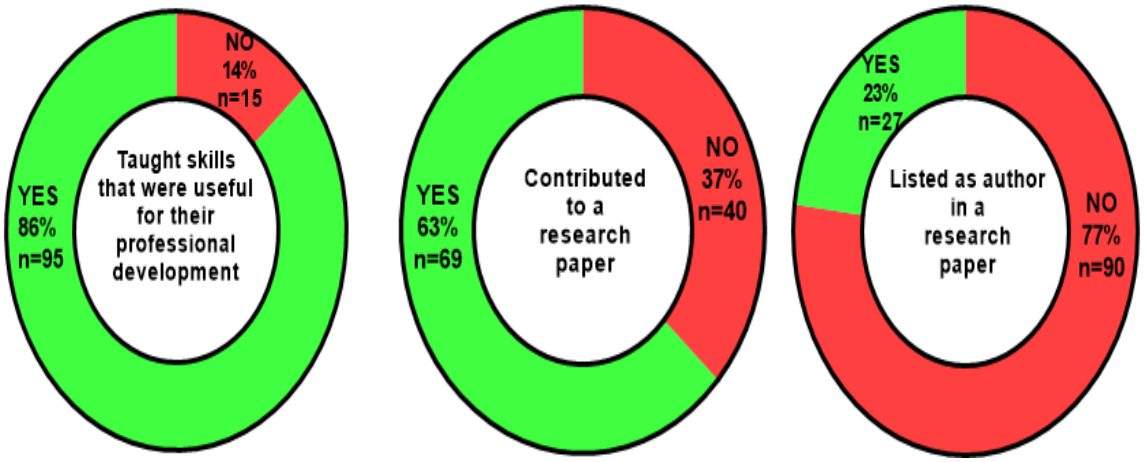

Figure 2. Research Technicians' Skills Gained and Contributions to Research Papers. Survey responses to understand research technicians Skills and Abilities were collected. Survey items presented in the middle of each graph. "Parts of whole" graphs were created using GraphPad Prism version 7.03 for Windows, GraphPad Software, La Jolla California USA, www.graphpad.com, displaying the proportion of 'yes' and 'no' responses. Yes, responses denoted by green, 'no' responses denoted by red. RTs indicated that 86% learned skills for future professional development, 63% contributed to a journal article, and 23% listed as an author. N=number of RTs responses

When asked to explain what these skills were, the respondents gave an array of answers. We list a few responses taken directly from the dataset that represents growth in critical thinking and technical research skills among the technicians indicating a graduate school focus. The majority indicated that they were learning crucial skills and protocols that will prepare them for future graduate study.

Table 4 shows examples of RTs 'responses, along with their job titles and years of experience.

Table 4. RTs Self-reported Skills, with Job Title and Years of Experience Noted

"The research I am doing is geared toward my interest and a specific Ph.D. program at BCM"; "I'm learning a higher level of microbiology." Research Technician II, less than 1 yr

"I've been learning new computational skills that are useful in genomics research." Research Technician II, less than 1 yr

"It is teaching me research techniques and methods that could be useful if I chose to pursue this line of graduate research." Research Technician II, less than 1 yr

"Learning about microbiology that I never learned as an undergraduate"; "Most definitely has tested my critical thinking skills!" Research Technician I, less than 1 yr

"use of advanced lab equipment and reporting study results using correct database formats and Quality Control procedure". Research Technician II, 1-3 yrs

We provide a few responses that represent an increase in biomedical science knowledge, responsibility, and patient interaction below from the technicians indicating a medical school focus.

"An abundance of patient interaction." Research Technician II, less than 1 yr

"Animal surgery under a microscope has improved my manual dexterity which I will need." Research Technician II, 1-3 yrs

"Builds responsibility and motor skills." Research Technician II, less than 1 yr

"Keeps me abreast of biological systems as well as new information in medicine." Research Technician II, 1-3 yrs

"I think it allows you to learn a lot about what is happening behind the scenes in the medical field besides just direct patient care." Research Technician II, less than 1 yr

Another group of responses indicates specific clinical technical and communication skills learned while working as technicians.

"*Planning and learning IRB, and clinical trial structure, New skills in Immunoblot, and MTT drug effect on cells."* Research Technician I, less than 1 yr

"My understanding of the human genome and the associated diseases/abnormalities has grown dramatically in the past year. My current job also uses higher level analytical and problem-solving skills on a daily basis." Research Technician I, 1-3 yrs

"I learn about cardiology and hemodynamics. Plus, I learn data management and protocol writing." Research Technician II, less than 1 yr

"Obtaining Presentation skills and speak and write in a scientific professional manner." Research Technician III, less than 1 yr.

One of the survey participants summed up their experience this way: "*I am planning to go to medical school, and some can say what I do at work is not directly related to medicine. But I am learning how to treat samples from subjects, collecting data, see if there is any pattern/correlation. What kind of bacteria are harmful vs. beneficial, how to utilize the*

microscopic information in relation to patient health are useful skills and mind-set needed for later career in my life." Research Technician II, less than 1 yr.

Abilities. Ability, a science competency, can be recognized by several characteristics such as problem sensitivity, deductive, and inductive reasoning (Carnevale et al., 2011). O*NET defines Ability as enduring attributes of the individual that influence performance. The Ability categories are creativity, innovation, mathematical reasoning, and oral and written expression (O*NET). The research laboratory environment is an essential venue for the development of this science competency. RTs 'involvement in scientific, scholarly pursuits is a demonstration of the Ability science competency. We wanted to know if RTs participated in activities such as contributing to a journal article. Many of the research technicians (63%) indicated contributions to research publications. However, 77% of technicians had not contributed to the research in ways that enabled them to be a co-author. The difference in the percentage of technicians indicating they had contributed to a research paper and the percentage of these same technicians who were indeed co-authors suggests that respondents defined contributing to journal publications a bit more broadly than we did.

Our analysis revealed that contributing to a research paper could mean that the RT only assisted with data collection, possibly not the analysis or writing. Therefore, being acknowledged in the manuscript, instead of being designated as a co-author, was the experience of most. Of those technicians who had contributed, several had been named as an author on at least one publication (10%), with an additional 13% co-authoring two or more publications. The data ranged from zero technicians co-authoring publications to one technician who had co-authored eight publications. The mean number of publications for the group stood at 0.6, suggesting that the most common experience is that technicians are not listed as an author.

Given that the U.S. biomedical workforce has a significant shortage of women and minorities, we looked at the citizenship status reported by the survey respondents. To better understand the potential pool of advanced degree candidates at BCM, we disaggregated RTs 'terminal degree interests by citizenship and compared the results using Chi-Square tests (Figure 3). Data show that 78% of RTs at BCM identifying as U.S. citizens were interested in earning a terminal degree (M.D. or Ph.D.) compared to only 53% of non-U.S. citizens (χ2=7.202, df=1, p<.01). More specifically, the data showed that U.S. citizens were statistically more likely to aspire to earn an M.D. than their peers who were non-U.S. citizens, 56% versus 17%, respectively (χ2=15.790, df=1, p<.01)). Research Technicians who have already earned master's degrees were statistically more likely to aspire to earn a Ph.D. than to pursue other terminal degree options (data not shown).

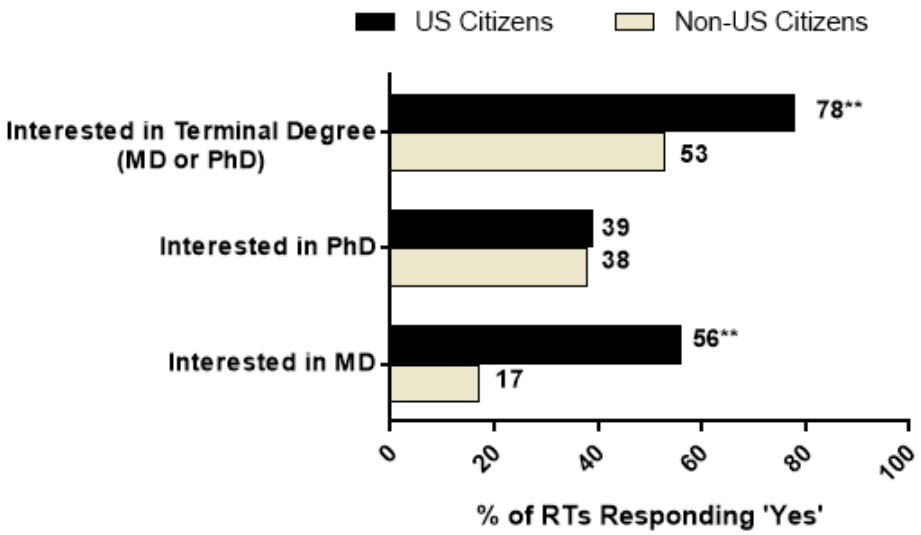

Figure 3: Research Technicians' Terminal Degree Interests Disaggregated by Citizenship. Comparison bar graphs were created using GraphPad Prism version 7.03 for Windows, GraphPad Software, La Jolla California USA, www.graphpad.com. Data were analyzed using Chi-Square testing in IBM SPSS Statistics for Windows v.21, IBM Corp. Released in 2012. Armonk, NY. Research Technicians' interest in earning Ph.Ds. or M.Ds. disaggregated by citizenship. "Terminal degrees" have been defined as M.D. or Ph.D. aspirations. Each bar represents the percent of Research Technicians responding 'yes' to the survey item. Darker bars represent US citizens, lighter bars non-US citizens. Seventy-eight percent of U.S. Citizen's indicated an interest in a terminal degree, with the majority (56%) interested in an MD. U.S. Citizens (39%) and non-U.S. Citizens (38%) had a similar interest in a PhD. Asterisks (**) indicate statistically significant differences ($p<.01$) between US citizens and non-US citizens.

Potential Advanced Degree Seekers in Technician Pool. To further understand the potential pool of advanced degree candidates at BCM, we filtered RTs 'survey responses to answer Research Question 1 (Figure 4). This analysis would also reveal the level of support they may require for admittance to a degree program. These filters began with one of the least restrictive criteria, i.e., RTs interested in earning a Ph.D. or an M.D. Filters (identifying as U.S. citizens, seeking employment at BCM with the intention of gaining admission to one of these programs, taking the GRE/MCAT, and identifying as under-represented minorities (URM) were then added to further refine the pool, ultimately to predict the potential number of highly qualified and proactive URM candidates who are likely already at BCM and interested in earning a Ph.D. or an M.D. In Figure 4, survey responses show that 71% of the RTs in the sample (82 out of 116) were interested in earning a Ph.D. or an M.D. Of the 82 who expressed interest in earning a Ph.D. or M.D., 62 (76%) were U.S. citizens. Thirty-nine of these 62 U.S. citizens (63%) had sought employment at BCM intending to gain admission into one of these degree programs. More than two-thirds (69%) of these RTs (27 out of 39) had also taken the GRE or MCAT. Lastly, the data show that 30% of RTs who had met all of the prior filters also identified as members of under-represented groups defined by NIH.

The RT position increases the science competencies necessary for graduate and medical degree attainment. Because we aimed to document how technicians prepared for entry into terminal degree programs, a subset of common activities was selected relevant to technicians 'daily tasks appropriate for those preparing for entry into advanced degree programs. These activities included department seminar attendance, informational (admissions) workshop participation, guidance concerning admissions process from PI, and mentorship. We used these variables to determine the specific academic and professional choice (Figure 5) activities participated in by the technicians.

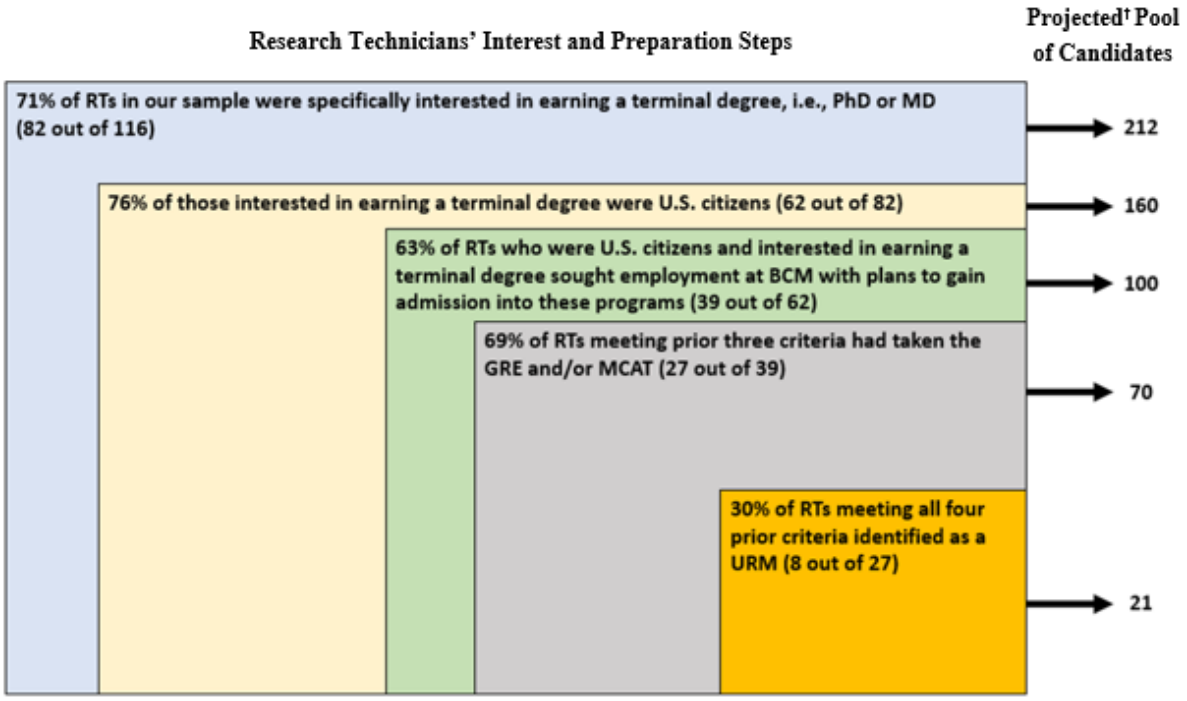

Figure 4: Pool size predictions. Survey responses regarding RTs interest and preparation were used in a layered fashion to determine potential terminal degree-seekers in the RT population. The nested area figure was created using Microsoft PowerPoint for Office 365 v. Oct 2018, Redmond, WA. The largest rectangle represents the entire set of Research Technicians in our sample that was interested in earning a terminal degree. Terminal degrees defined as a Ph.D. or an M.D. Each nested rectangle represents a filter applied to the set of Research Technicians who were interested in earning a terminal degree. These nested rectangles have been drawn to be proportionate (in the area) to the larger rectangle in which it sits, with each filter being additive and further restrictive. Projected values (denoted by †) calculated by taking the percent of RTs in our sample who met those criteria and multiplying those percents by the projected 300 Research Technicians employed at BCM. Evergreen (2017).

The department seminar is an informal training tool for developing scientists. Seminar attendees learn firsthand from local and national scientists about cutting edge research studies of interest to them and increase their breadth of knowledge through these presentations. Learning how to give effective presentations and recognizing elements of a subpar seminar sharpen science

communication skills. When the laboratory or department is serving as host, the entire laboratory staff, including graduate students, postdocs, and technicians, attend. Speakers are invited to give research talks at the request of BCM faculty to bring scientists together who work in specific fields of interest to the institution. Often Nobel laureates and high-profile scientists in the field are invited, and graduate students and postdocs use these visits as an opportunity to network with people whose work they have previously read. Department seminars occur weekly at BCM and other biomedical research institutions around the country and are usually the only time everyone in a program comes together. These opportunities can build social and intellectual relationships. Figure 5 indicates that nearly 71% of the RTs attend department seminars.

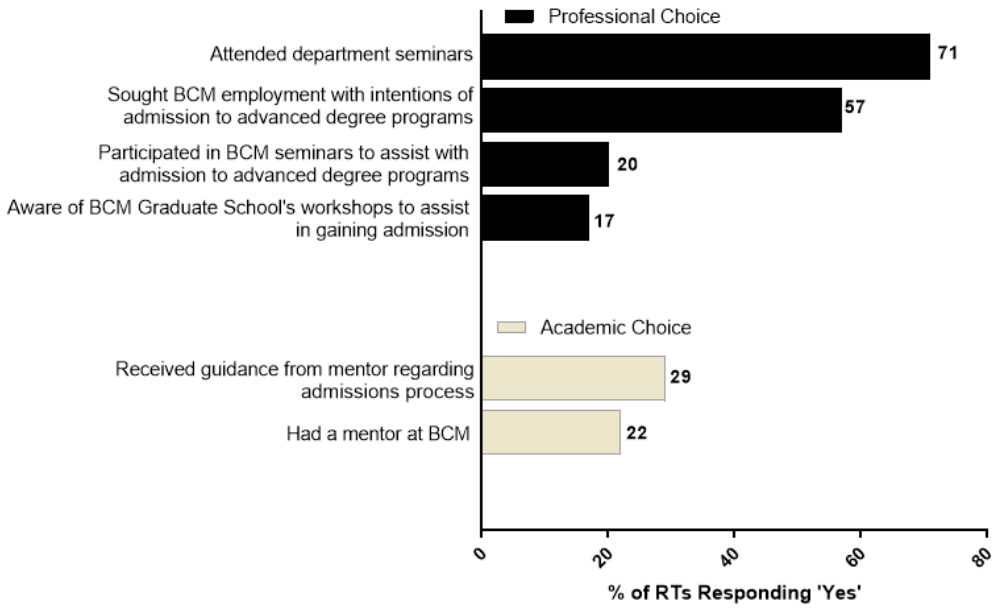

Figure 5: Research Technicians' Responses to Academic and Professional Choice Variables. From survey data, four variables connected to professional choice, and two connected to academic choice were selected. A group bar graph was created using GraphPad Prism version 7.03 for Windows, GraphPad Software, La Jolla California USA, www.graphpad.com. Darker bars represent professional choice, and lighter bars academic choice variables. Each bar represents the percent of Research Technicians responding 'yes' to the survey item.

We also wanted to know if the RTs were taking advantage of BCM opportunities that provide information about admissions to aspiring graduate and medical school applicants. The graduate school offers workshops in the fall on topics relevant to gaining admission. The medical school does not offer an information session like other BCM graduate programs, but will meet personally with each employee to discuss their qualifications and preparation for submitting applications. To determine if the RTs were aware of the informational sessions offered by the

medical and graduate school, we asked, "Have you participated in any BCM informational seminars to assist you for future admission into any of these programs?" Only 20% of the RTs had attended information sessions at BCM. This left 80% of the employee advanced degree seekers unaware of the opportunities to learn more about the institution's admissions process and requirements.

Seeking employment at a biomedical research institution could also increase a technician's ability to establish a mentoring relationship. Mentoring is a relationship between a professional (the mentor) who assists another (the mentee) in developing specific skills and knowledge that will enhance the less experienced person's professional and personal growth (Management Mentor, 2019). We wanted to determine if RTs received expert guidance in preparing for graduate or medical school. The survey asked, *"Do you have a mentor at BCM?"*, which would indicate seeking advice from a faculty member or someone associated with the graduate or medical school. Only 22% of RTs indicated that they had mentors at BCM, leaving many of the technicians (78%) without a mentor. We then asked, "D*o you receive guidance concerning the admissions process from your PI*?". The majority of the technicians did not receive any guidance from their PIs (71%) (Figure 5). A small number of RTs had discussed career goals and received direction from their PIs (29%).

Determining a Relationship between Academic and Professional Choice for Technicians Pursuing a Terminal Degree. After we identified significant predictors for Research Technicians 'interest in pursuing an M.D. or a Ph.D., we examined the relationship between academic and professional choice variables and a desire to pursue a terminal degree (dependent variable) among research technicians in the biomedical sciences. We sought to explore the predictive capabilities of academic and professional choice (independent variable) on interest in pursuing entrance to an M.D. or Ph.D. program. A binary logistic regression was performed to examine the relationship between 'academic choice', 'professional choice 'and interest in pursuing a terminal degree among research technicians. Regression results indicated that the overall model of the two predictors was statistically reliable in distinguishing between those research technicians who desire to pursue the terminal degree and those who did not ($\mathbf{X}^2$(df=2, n=94) = 8.293, p<.016) (see Table 5). According to Nagelkerke R-square test, the variables 'academic choice 'and 'professional choice 'combined accounted for as much as 14% percent of the variance in predicting pursuing a terminal degree. The model, including the two variables of academic choice and professional choice, proved to be 83% successful at predicting which RTs would likely look to pursue a terminal degree). Regression results show that RTs interested in a terminal degree were two times more likely to answer 'yes 'to a professional choice variable than their peers not interested in a terminal degree (z=5.985, CI [1.167, 4.050], p=.014). However, the group of RTs interested in a terminal degree was no more likely to answer 'yes 'to academic

choice variables than their peers not interested in a terminal degree (z=0.267, CI [0.519, 3.078] p=.605).

Table 5: Logistic Regression Modeling of Predictive Power of Academic and Professional Choice to Research Technicians' Interest in Earning a Terminal Degree; CI = confidence interval

	Unstandardized Coefficients		Odds ratio [95% CI]	
	B	SE B	Exp(B)	
Professional Choice*	0.777	0.317	2.174	[1.167, 4.050]
Academic Choice	0.235	0.454	1.264	[0.519, 3.078]

A binary logistic regression analysis performed with IBM SPSS Statistics for Windows v.21, IBM Corp. Released in 2012. Armonk, NY. The outcome was a dichotomous variable documenting whether a Research Technician was interested in a terminal degree. Terminal degrees were defined as a Ph.D. or an M.D.. Two predictor variables included in the model, academic choice and professional choice. Academic choice was an aggregate of 2 survey items, and professional choice was an aggregate of 4 items, further outlined in Figure 5. Results of the regression show a significant model, $\mathbf{X}^2(2, n=94)=8.293$, $p<.016$; Nagelkerke $R^2 = .141$; One of the two predictor variables, professional choice, proved to be statistically significant at the 0.05 alpha level, denoted by the asterisk (*).

Discussion

We began this study to understand better why research technicians seek employment at research-intensive biomedical institutions. When asked, most faculty (BCM, Purdue University, University of Massachusetts-Amherst, University of Texas-Health Science Center-San Antonio, Washington University-St. Louis) believe college graduates focus attention on positions at these institutions to gain an edge for acceptance to graduate or medical school.

When investigating the career choices of underrepresented minority students that participated in an intervention program at the University of California-Davis, Villarejo et al. (2008) reported that 14 survey respondents opted for a career as a biomedical technician compared to 24 for Ph.Ds. They listed a few ways the career biomedical technician differed from the Ph.Ds.: they had a lower average GPA; only 57% of them graduated with a GPA above 3.0 and valued the research experience for the resume building skills. The Villarejo et al. (2008) study characterized the research technician who tended not to be interested in pursuing a doctorate. As we began to collect data, more reports emerged concerning the shortage of STEM trainees for future jobs in public and private industries along with the National Institutes of Health and National Science Foundation budgets tightening for biomedical training resources (Kaiser, 2011,2013, and 2015; 2012 U.S. Joint Economic Report; Rothwell, 2013; Wadman, 2013). As a group of college-educated, well-trained, skilled workers, RTs could be an excellent resource for future STEM jobs across many industries.

Among the respondents to this employee survey, the majority of the research technicians did seek employment to gain admission into professional school at BCM (57%). This study population did consider graduate and medical education, but did not have a formal path to meet their career goals. The SSCT framework that guided this research study defines professional career choice goals as the intention to engage in a particular action to series of actions (terminal degree attainment) (Lent al., 1994). We wanted to understand how RTs committed to their career goals. Our data showed that this population of Research Technicians was mainly female (64%) Research Tech IIs, and employed between 1-3 years. Although Caucasian American and Chinese technicians were the largest groups represented, many who are underrepresented in STEM (and having a Ph.D. or M.D. degree interest) were well-represented among the RTs in this study. The 2015 NSF report reveals that Caucasian and Asian women earned nearly half of the science and engineering degrees awarded to their respective racial and ethnic groups. In most science and engineering fields, the share of bachelor's degrees earned by under-represented minority women is more significant than their shares of master's or doctoral degrees. Although 70% of the RTs had a bachelor's degree, a considerable number were presently continuing their education by taking courses to obtain an undergraduate degree or a master's (data not shown). Of the eleven demographic variables included, variations among four of them were statistically significant when disaggregated by career aspiration. Survey data suggest that the aspirations to earn advanced degrees were statistically the same across gender, ethnicity, race, age, and primary language that is spoken at home.

We wanted to determine if the RTs interested in gaining admission into professional schools exhibited the characteristics of a serious and committed applicant. SCCT predicts (Lent et al., 1994) that the more valued the perceived outcomes, the more likely people will adopt particular career goals and active courses (paths). Thirty-seven percent of the RTs took the GRE. The self-reported quantitative score range was competitive for admission, falling within the program averages for the majority of the top tier graduate programs in the country. The verbal score range self-reported by the technicians was also competitive, although they did not score as high on this section. Before the GRE was changed, individuals accepted into BCM's graduate program had similar scores as those reported by the RTs. We also saw that 21% of them took the MCAT. The range of the MCAT scores, however, was not as impressive as the range of GRE scores reported by the technicians interested in graduate school. We believe that both the low percentage of MCAT takers and unexceptional scores may indicate that the majority of M.D.-interested technicians decided later to pursue this career path than second semester undergraduate juniors who generally take the exam. They also may be over-preparing and allowing anxiety to dictate sitting for the exam. The RTs attended departmental seminars (~71%) indicating an interest in scientific research topics and a willingness to learn and develop critical thinking skills rather than only performing a job duty. Successful performance will tend to enhance self and outcome percepts, thereby strengthening one's interests and goals (Lent et al., 1994). The RTs also saw value in skills learned and performed in the research laboratory. Some

of the technicians have received opportunities for direct patient interaction, improved manual dexterity, learned about "behind the scenes" activities in medicine, and gained problem-solving skills. RTs indicated that these skills increased their understanding beyond their undergraduate training and were useful in the specific type of research they planned to pursue.

The data we collected concerning publications among the technicians were inconclusive for our study purposes. About 10% of the technicians were co-authors on research publications, but 63% indicated that they contributed to a research paper. It appears that there are many factors involved in the research technicians 'ability to contribute to a research journal article, and that effort does not necessarily lead to co-authorship. Authorship determination practices are not uniform across research laboratories, and publishing is not a job requirement for the RTs. This variability would have a significant effect on the number of publications an RT could co-author. We believed the number of publications among this group could help understand the commitment to gaining experience that would contribute to their admission into graduate/medical school.

To address Research Question 1, we asked what percentage of Research Technicians were potential advanced degree seekers. Based on our calculations using survey data and applying filters for survey responses, we calculated projections for advanced degree-seeking RTs. Assuming these percentages uncovered in the sample hold for the roughly 300 RTs employed at BCM, it is highly likely that more than 200 RTs (including 160 U.S. citizens) are interested in earning a Ph.D. or an M.D. Providing a pathway for a subset of these RTs who are U.S. citizens to gain admittance to terminal degree programs may be beneficial to the institution. Projections suggest that roughly 100 of these RTs specifically sought employment at BCM to gain admission into one of these advanced degree programs, while roughly 70 who met all previous three criteria have already taken the GRE or MCAT. Lastly, projections show that as many as 21 RTs who may have taken the GRE or MCAT may also identify as a race/ethnicity that is under-represented in STEM, showing that strong candidates for expanding the research pipeline may currently be employed at biomedical research institutions around the country.

It would stand to reason that seeking employment at an institution that awards M.D. and Ph.D. degrees would give employees a unique advantage. The most valuable opportunity would be the development of a relationship with a faculty mentor to assist with the application process or help to discover different career paths. We asked the technicians if they had a BCM mentor, and the answer was "no" for three out of four of them. But a small number of these technicians had formed mentoring relationships. We wanted to determine if the technician's PI advised on the application process when they sought this type of support. Data showed that only one in three of the technicians received this type of help from their PIs. This data point may also be an indication of some technicians 'lack of confidence in the working relationship with their PI to share their future career plans.

This group of technicians has demonstrated by their actions that they were serious in the pursuit of a graduate/medical degree. They trained in biomedical research and developed useful technical skills and abilities that would translate well in graduate/medical school. They felt these skills were vital for their professional development. They took advantage of being in a research-intensive environment by attending department seminars and contributing to research papers. They also took entrance exams and continued to learn through taking college courses. According to SCCT, interest promotes career choice goals (i.e., intentions, plans, or aspirations to engage in a particular career direction) which increases the likelihood of choice actions. Choice actions then lead to particular performance and achievement domains (Lent et al., 1994).

Our results highlight that mentoring of experienced RTs is critical for their future medical and science education progress. Studies concerning the benefits of mentoring show that individuals with positive mentoring experiences are more likely to be promoted, better prepared socially, more productive, have greater self- efficacy, happier in their jobs and have improved career satisfaction (Cho et al., 2011; Gardiner et al. 2007). The mentee receives valuable assistance to determine career goals, access to professional networks, and gain an understanding of the culture. Mentors serve many roles (academic advisor, supervisor, professional development coach, collaborator), but share knowledge and are trusted by the mentee (Shamoo and Resnik 2009; Macrina 2005; Comstock 2013; VCU 2002).

To address Research Question 2, we asked what variables were significant predictors for Research Technicians 'interest in pursuing a Ph.D. or M.D. We used a binary logistic regression analysis to determine the variables that were strong predictors of RTs aiming to pursue terminal degrees after seeking employment at a biomedical research institution. The following six variables combined to comprise a statistically significant model for differentiating terminal degree seekers from non-terminal degree seekers ($\mathbf{X}^2$(df=2, n=94) = 8.293, p<.016): *If you are interested in a Ph.D. or M.D., did you seek employment at BCM with plans to gain admission into these programs? Do you attend departmental seminars or seminars for invited speakers (special symposiums at BCM)? Have you participated in any BCM informational seminars to assist you for future admission into any of these programs? Do you receive guidance concerning the admissions process from your PI?; Do you have a mentor at BCM? Are you aware that the BCM Graduate School provides workshops on topics that will assist you in gaining admission into graduate school?*. Of these six variables, the cluster that makes up professional choice (z=5.985, CI [1.167, 4.050], p=.014) was the strongest predictor where RTs were twice as likely to pursue a terminal degree than RTs not interested in a terminal degree. The RT data correlated with activities provided in most post-baccalaureate programs to prepare underrepresented groups for doctoral programs.[3]

[3] The University of North Carolina-Chapel Hill PREP (Post-baccalaureate Research Education Program) scholars were successful at entry into doctorate programs after receiving laboratory research and critical analysis of scientific literature training (Hall, 2016). Although these activities, along with others are part of a formalized program, it provides evidence that the RTs participation in these activities contributes to the pursuit of the Ph.D.

Unlike any other profession, mentoring in the biomedical sciences is tightly linked to the professional trajectory of academic and professional careers (Ynalvez and Ynalvez, 2017). Most PIs focus on mentoring the trainees in their laboratories in advanced degree programs. In general, this type of mentoring is often not available to the non-graduate degree seeking technicians who work in their labs. These technicians are many times considered to be part of the labor workforce and there to provide a service. This study indicated that few technicians received mentoring that facilitated professional advancement. Under SCCT, self-efficacy is strengthened, and expectations of positive outcomes for career goals are formed, by personal experiences of success, exposure to and mentoring by successful role models, positive reinforcement, and positive affective experience during activities related to career goals (Gandhi and Johnson, 2016). The lack of mentoring for these technicians 'progress is an area for potential improvement as a route to graduate/medical school. It has been an informal path taken by these technicians, but could be a viable career track with some additional training elements. Mentoring involving individual advising, coaching, and professional guidance along with self-efficacy beliefs, and the other environmental factors could be involved in the research technicians 'path to graduate professional programs.

The influence of guidance provided by mentors is another possible explanation that may be due to the lack of PI support toward RTs' goals. This may also be why the majority of RTs were not as accomplished in areas such as co-authoring journal publications. We find that some formal mentoring structure, as well as participating in academic activities, may be significant in the success of RTs gaining admission into graduate and medical schools. The potential for academic success by research technicians was shown in the Rivera and Murray (2014) study. Those who participated in a post-baccalaureate program that created a learning environment inside the same institution supported the success of the participants to gain admission into graduate school. Alumni survey results from this post-baccalaureate program population in Ph.D. training programs indicate that mentoring was extremely important for their success in gaining admission.

Possible solutions for the success of the RTs in the current study are an assurance from the administration that seeking career advancement advice would not result in job loss, and/or a technician mentoring plan could be implemented without additional burden on the faculty. One mentoring plan could involve the postdoctoral Research Fellows, a group of employees in biomedical institutions poised for developing attributes that will make them more attractive for the job market. The postdoctoral Research Fellow is interested in teaching and mentoring

degree. Furthermore, the findings emphasize that these types of experiential learning contribute to the theoretical framework. It is plausible that participants' decision to participate in professional choice activities seem to be crucial elements in the determination to pursue an advanced degree. In addition, institutions that provide access to support activities associated with professional choice increase the pool of available and, more importantly, viable candidates for Ph.D. and M.D. programs.

opportunities to increase their skills for professional growth and career advancement. The postdoc associations provide professional development training on various topics (grant writing, teaching) and could include more mentoring sessions and specific topics (graduate and medical school admissions process) to help facilitate PostDocs 'skill development in this area. Training research postdocs to serve as mentors for the research technician could contribute to increasing the numbers of scientists and physicians in this country and address the shortages among the underrepresented groups. In Figure 6, a pathway model is presented that includes dedicated mentors provided by the institution who could help facilitate a successful number of RTs entering into terminal degree programs. The Research Technician pathway is a viable route and could help address the training of U.S. citizens for the biomedical workforce.

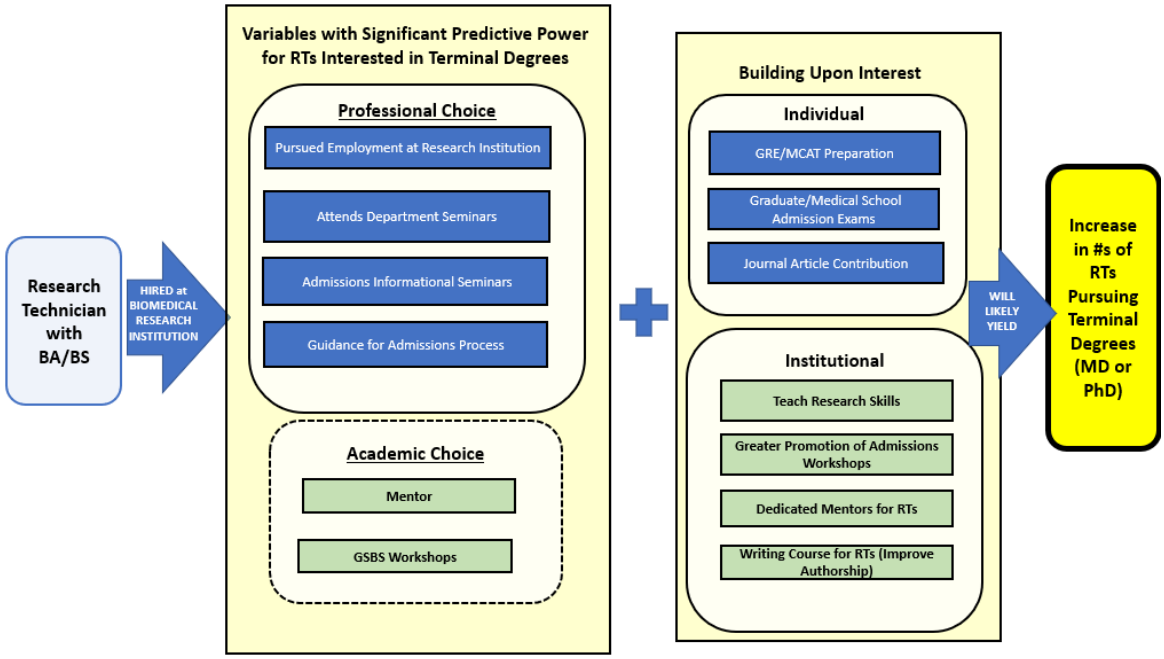

Figure 6. Pathway Model for RTs with terminal degree interest. The results of this study are used to devise a pathway for RTs pursuing terminal degrees. Individual efforts along with institutional assistance that include the variables with significant predictive power from the study can lead to an increase of RTs pursuing terminal degrees.

Study Limitations and Future Studies. There were several limitations to this study. First, recruiting the participants from one institution presents challenges to generalizing. Because this was an anonymous exploratory study, the researchers could not conduct a follow-up survey with this same group. BCM does not track RTs' admission into graduate or medical school; it would be helpful to know how many RTs are admitted each year to determine the success of this group toward accomplishing their goals to pursue an advanced degree. Another limitation is that the study includes primarily self-reported data from technicians regarding mentoring, guidance, and participating in academic activities. Collecting complementary data directly from mentors might

have strengthened our findings by further highlighting strengths and gaps in the support PIs provided to research technicians. Lastly, the incentive to offer a medical school admissions workshop could introduce bias to those pursuing a medical degree. While analyzing the data for this study, we found several interesting items (subgroup degree interests, Research III's career interest, and variations among demographic variables) that we will investigate in future studies.

This study demonstrates for the first time that a substantial subset of Research Technicians at biomedical institutions could be interested in pursuing an M.D. or Ph.D. Research Technicians likely enhance their interest in the biomedical sciences by engaging in professional and academic activities and developing skills in which they view as important to pursue a terminal degree. The additional training research technicians receive in the lab can be perceived as an alternate path to graduate education. We believe that biomedical institutions should consider this unique group of trainees to increase the U.S. graduate and medical student population. These institutions could identify strategies to address academic variables affecting persistence into professional degree programs. As a result, low-cost internal training programs could be developed to address the unmet need that would help potential professional school trainees achieve their goals to pursue Ph.D. and M.D. degrees. The RTs in this study acted on the belief that obtaining an M.D. or Ph.D. is attainable by adding experience through employment at a biomedical institution, taking GRE/MCAT, and increasing critical thinking skills along with other science competencies. These RTs demonstrated self-efficacy and outcome expectations, and more studies are needed to determine if the group at each respective biomedical research center demonstrates the same tendencies.

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