The Academic Impact of Majoring in Technology for First-Generation College Students

E. Shirl Donaldson
Purdue University
edonalds@purdue.edu

Ryan N. Favors
Purdue University
rfavors@purdue.edu

Abstract

There has been a strong movement towards improving the numbers of students majoring and graduating from college in the science, technology, engineering, and mathematics (STEM) fields. This increase in first-generation college students' enrollment prompts an increase in enrollment in STEM education. Typically, first-generation students struggle to master STEM fields' course work because of inadequate math preparation and an overall lack of understanding of STEM fields. Most first-generation students come from high schools where there is little or no knowledge of technology as an academic major. When the STEM acronym is considered, the general population tends to be more familiar with traditional majors such as science, math, and engineering; however, many technology units in academia have been in existence less than 60 years. The limited presence of technology as an academic major is a source of obscurity. In tandem, the difference between studying engineering and studying technology are not fully understood; consequently, many students choose to major in engineering when technology should have been considered. In regards to the first-generation student population, there has been an increase in students switching from other majors to technology. The students report experiencing academic improvement, thriving in a specific area, and ultimately leading to great careers.

Students whose learning styles are related to a more kinesthetic or tactile approach tend to thrive in the field of technology. This is a plausible reason why first-generation students routinely excel in technology rather than engineering. The aim of this study is to focus on the impact that majoring in technology has on first-generation students as well as advancing their careers in a STEM field. This paper is a summary of a pilot study at a single university.

Introduction

Since 2007, there has been a national increase in the enrollment of first-generation students. Documentation shows an increase from one out of five students enrolled in 2007 to one out of three students enrolled in 2012 [1]. This increase can be attributed to these students' motivation to enroll in college as a deliberate attempt to improve their social, economic, and occupational standing [2]. With this motivation in attending college might be an increase in first-generation students majoring in science, technology, engineering, and mathematics (STEM) fields, specifically in engineering, because of well-publicized salaries for engineers. A rigorous course load is standard for engineering majors, and, unfortunately, most first-

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generation students are not prepared for this level of coursework due to poor academic expectations [3]. Most students have not been introduced to, nor grasped, the concept of technology as being “applied engineering.” From our study, we believe more first-generation students could graduate with a STEM degree if they were adequately informed about choosing technology as a major.

Who Are First-Generation Students?

There are various definitions for describing a first-generation student. The most widely accepted definition, the one used by federal TRIO programs (Upward Bound, Talent Search, and Student Support Services) and the one used for this study, is an individual both of whose parents did not complete a baccalaureate degree or the individual who regularly resided with and received support from only one parent who did not complete a baccalaureate degree [4]. A few characteristics of first-generation students are underrepresented minorities, female, non-traditional, and from low-income families [5]. This group of students usually attends college at a lower rate than other demographics, and data show a lower completion rate for them as well.

Definition of Key Terms

Key terms used in this study are defined below:

College of Technology: an entity that centralizes the university’s applied learning programs into one administrative/academic unit [6]

Major in Technology: a concentration in a field of study that focuses on technology; any tool or operating system designed to improve the efficiency, quality, and competitiveness of an organization

STEM: science, technology, engineering, and mathematics

Technology: “the creation of new and useful device, machines and systems to include the purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities” [7]

Underrepresented Minority: as defined by the National Science Foundation “three racial/ethnic minority groups (Blacks, Hispanics and American Indians) whose representation in science and engineering is smaller than their representation in the U.S. population” [8]

Background

There has been a documented increase in first generation-students attending college. This increase of first-generation students in college can be attributed to the quest for better economic standing, improved social standing, as well as an occupational viability. Many students realize that progressing into higher education is a beneficial to improve their economic status. However, they also realize that university studies are not the only way to advance financially.

Concurrently, students are also noticing that earning a college degree gives them an opportunity to obtain a job at a higher entry level compared to that of a person with a high school diploma. Even though first-generation students have more motivation to attend college, they are still faced with barriers that keep them from succeeding as students whose parents attended college. See Figure 1.

Average salary by education level

	2006-07	2007-08	2008-09	2009-10	2010-11	Previous Year % Change
High School	$61,243	$60,912	$66,222	$65,127	$66,940	2.8%
Military	$64,476	$63,495	$68,011	$65,398	$68,192	4.3%
Vocational/Tech School	$53,560	$55,785	$58,261	$58,941	$60,116	2.0%
Some College	$64,148	$65,138	$69,947	$69,802	$69,927	0.2%
College Graduate (4-Year)	$73,676	$74,842	$77,704	$79,152	$78,788	-0.5%
Master's Degree	$85,137	$87,507	$92,445	$91,940	$93,465	1.7%
Doctoral Degree	$93,480	$94,763	$105,766	$103,286	$100,120	-3.1%

Figure 1. Statistics from US Department of Labor [9]

Income levels as well as viability are reflected in Figure 2 in terms of weekly unemployment rates during the recession in 2011.

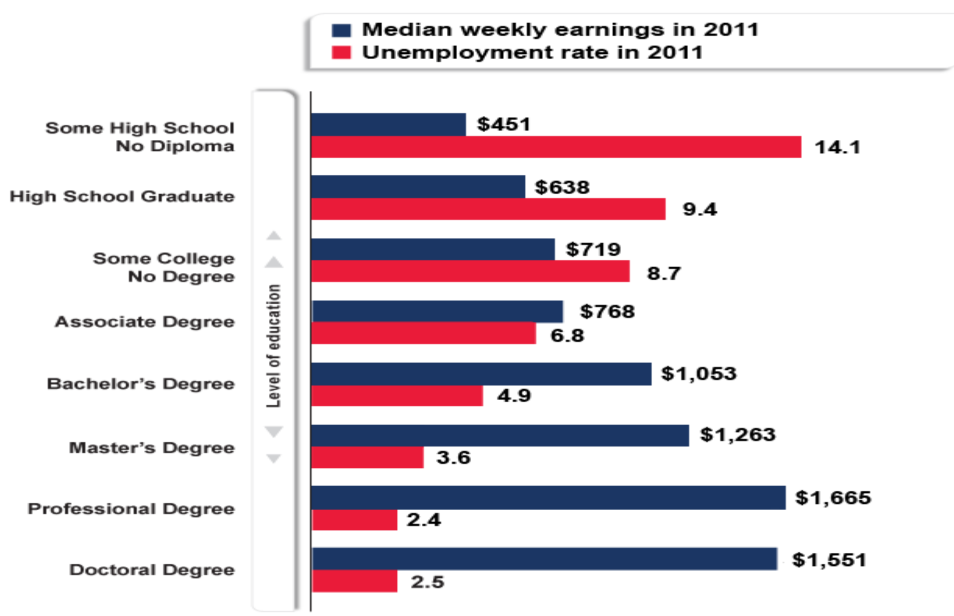

Figure 2. Weekly income and unemployment rates from the US Department of Labor [9]

Barriers to Entry and Perceived Barriers to Completion

According to Schmidt [10], there are barriers or obstacles to completion and persistence in the STEM fields of study. Preparation, attitudes, and persistence of first-generation students in technical areas are by-products of a similar system functioning at the K-12 level of education. Groundwork in high school is critical for success in college [11]. Socio-economic status and school district funding set the stage for early childhood education. Neighborhoods inhabited by certain populations often received limited resources for substandard educational support based on tax revenues. Consequently, if society does not plan for certain students to attend college after high school, the plan of action is different. The K-12 system produces college-ready applicants at a desired level in desired locations. The logic employed in this scenario was that future factory workers do not need college preparation mathematics and science courses in high school as stated by Carnevale and Schulz: “The elementary and secondary schools in America are adequate at educating the designated college bound students, but [they] are not successful at preparing the non-college bound youth” [12] . Unfortunately, these perceived non-college bound youth are often Black or Latino and of lower socio-economic status. That article was written in 1988; now, almost 25 years later, there is a gaping hole in the pipeline of diverse and underserved students who are prepared for STEM majors in college and graduate school [13].

Barriers Outside of Academia

A noticeable barrier first-generation students face is lack of educational goals [14]. First-generation students typically do not have the same drive for success in college as do students whose parents attended college. Some might see college as intimidating, so the social aspect of college is daunting for first-generation students as well. First-generation students struggle more with seeking advice with logistical challenges of higher education, such as how to register for courses, career advice, academic advising. Some of their initial struggles could be linked to not having much support from high school counselors [15]. Once the student arrives on campus and realizes the lack of aspiration to succeed in college compared to peers, the student’s self-efficacy drops. This phenomenon becomes apparent when a student is not in a major or field of study that coincides with individual academic strengths.

Parental influence is a huge barrier first-generation students must face and manage [16]. Parents who have never attended college usually are intimidated by not knowing or understanding the issues faced in college and usually shy away from communicating with their adult child. Some parents don’t recognize the benefits of college and may knowingly or unknowingly discourage their child from succeeding.

The most documented barrier to mention is the financial burden of college. Typically, first-generation students can’t afford the fees and additional expenses to attend college based on the increasing costs of many universities [17]. The ones who do attend usually spend a significant portion of their time working to take care of any financial burdens or monetary need. Working part-time takes away from a first-generation student’s time to study. Unfortunately, the need for immediate income becomes more important, especially when compared to a student whose parents attended college and are able to provide better financing. While these three barriers are not the complete list, they represent the most documented and impactful challenges for first-generation students.

Relevance

National Focus on STEM

Nationally and locally, there is an obvious need for more people to pursue and obtain advanced degrees, especially in a STEM field [18]. The President of the United States has declared an initiative to increase the number of women and underrepresented students in STEM education as well [19]. This push for increasing participation is due to the lack of students graduating with STEM degrees combined with the need for this expertise in the new economy.

The increase of first-generation students entering college prompts an increase of first-generation students majoring in STEM fields. The decision to choose a STEM major may be driven by the same motivating factors that impacted the decision to attend college. The choice of a STEM major can also be attributed to specific career focuses. In parallel, it is publicized that STEM field majors, especially in engineering and computer science, typically have higher paying salaries. Typically, having a STEM degree will enable an employee to have a more prominent role in a company after graduation.

The deterrents accompanying the increase in first-generation students majoring in STEM fields are the barriers these students will face. The major barrier appears be the lack of K-12 academic preparation in mathematics [20]. Higher achievement in levels and frequency of math courses is critical. For instance, students who do not master algebra by the end of eight grades are not prepared for college. Persistent students who succeed in advanced math classes in high school tend to have a positive sense of self-efficacy leading to college attendance.

Considering course load that a typical engineering or science major will encounter, poor math skills could possibly lead to failure on the collegiate level. In concert with the lack of self-efficacy from entering college, these students' confidence level will usually fall causing them to be placed on academic probation, leading to a status of "academically dropped." These students who are "dropped" usually do not return to finish their degree. Consequently, there becomes an additional risk for the student and their parents in the form of loan debt without the income to service it.

The present study is significant because of the trends in population growth of domestic first-generation students as well as the rising number of students needed to complete undergraduate studies at prestigious universities in a technical field. Concurrently, the economic decline in the United States has created a more competitive job market for recent graduates [21]. 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 [22].

The Evolution of Technology as an Academic Major

The debate about the amount of overlap continues between professors in engineering and those in technology. There are also varying opinions of discernment between theoretical engineers and applied engineers. Land [23] contended that engineering technologists are in fact engineers and has performed extensive research published by the American Society of Engineering Education (ASEE) to support his position.

The literature review in his most recent study claimed 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 [24]. Heiner supported Land's position by stating that people create technology to solve problems; however, technology can create new problems as well. The dawn of the information age and growth of computer technology hosted graduate degrees in technology in the early 1990s according to the History of Programs in Knoy Hall of Technology at Purdue University.

TECHNOLOGY	Average	ENGINEERING	Average
Aeronautical Engineering Technology	$51,540	Aero/Astro Engineering	$55,895
Building Construction Mgmt	$48,230	Construction Engineering	$54,625
Electrical Engineering Technology	$51,954	Electrical Engineering	$60,437
Industrial Technology	$47,171	Industrial Engineering	$56,938
Mechanical Engineering Technology	$48,437	Mechanical Engineering	$56,845
Computer Information Technology	$54,235	Computer Science	$59,090
Computer Graphics Technology	$41,474		

Figure 3. Starting salaries reported by the Career Counseling Office, Purdue University [25]

Research Design

Hypothesis: Given the low completion rates in science, engineering, and math, more first-generation students could graduate with a bachelor's degree in STEM fields if they were adequately informed about choosing technology as a major.

Theoretical Framework

Systems theory as defined by Patton [27] in qualitative research and evaluation methods was the supporting framework for the present research. Patton explained system theory as follows:

> Holistic thinking is central to a system perspective. A system is a whole that is both greater than and different from its parts. Indeed, a system cannot validly be divided into independent parts as discrete entities of inquiry because the effects of the behavior of the parts on the whole depend on what is happening to other parts. The parts are so interconnected and interdependent that any simple cause – effect analysis distorts more than it illuminates. Changes in one part lead to changes among all parts and the system itself. Nor can one simply add the parts in some linear fashion and get a useful sense of the whole [27].

Celebrated cultural competency consultant, Frances Kendall, defined higher education as a whole, and the individual universities that comprise it as a "system." Higher education is definitely a complex system [28]. More specifically, an individual university such as Purdue is viewed as a complex organization with interconnecting and multi-functioning facets.

Delimitations

The focus of the study was limited to domestic first-generation students in the College of Technology at Purdue University's main campus in West Lafayette, Indiana; international students were not used as subjects for the purpose of the study.

Assumptions

Participants were assumed to have answered all questions truthfully. This sample is criterion-based yet still convenient; all of the subjects were from the same college within one university's campus. The assumption is that the findings of the sample are representative of the population.

Population and Sample

Although the present research is not generalizable to a larger population, it is internally generalizable to the population examined [29], specifically the College of Technology at Purdue University.

Population Defined by the Institution

The population is defined as first-generation students that are also technology students or alumni of the College of Technology. The population of this pilot study was limited to Purdue University's main campus in the College of Technology. These 15 subjects were readily available and willing to participate.

Criterion Selection

Subjects in the present study had to meet both criteria. They must be a first-generation college student in the College of Technology [29]. They had to be enrolled or an alum of the College of Technology.

Subjects

A total of 15 subjects were selected. Seven of the participants were African-American, five were Caucasian, two were Hispanic, and one was Asian. There were no Native-American participants.

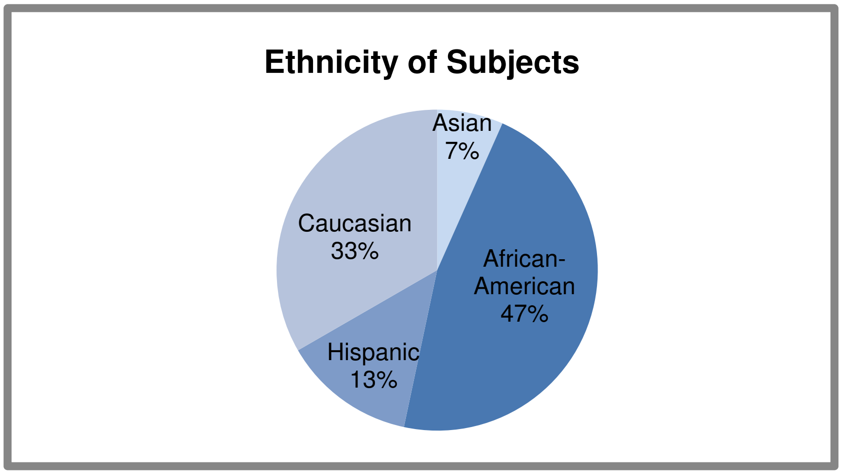

Figure 4. Ethnicity of subjects in the pilot study

Data Collection - Survey

A survey with pointed (yes/no or when) and open-ended questions was used to gather data. For inter-rater reliability, the research team was able to clarify any ambiguities using an additional objective coder [30].

Description of Analysis

Traditional manual coding that normally accompanies qualitative research was implemented for this mixed-methods study [31]. “Key words,” “key phrases,” and “redundant terms” were identified for further analysis.

Results/Discussion

The data listed are the answers from the participants in the pilot study. More analysis will be calculated once more participants have been interviewed. Of the 15 study participants, five students are majoring in Organizational, Leadership and Supervision (OLS), three in Computer Graphics and Technology (CGT), and two in Industrial Technology (IT). Aviation Technology (AT), Building Construction Management (BCM), Electrical Engineering Technology (EET), Manufacturing Engineering Technology (Mfg.ET) and Mechanical Engineering Technology (MET) each has one student majoring in its field.

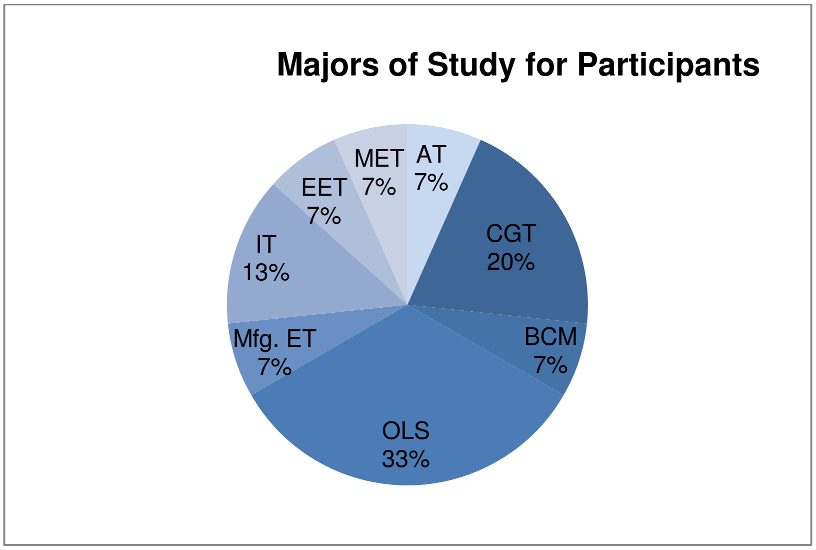

Figure 5. Participants majors in the College of Technology

Of the 15 students, five began their freshmen career in the College of Technology, while the other 10 students switched to the College of Technology after being enrolled for at least one semester.

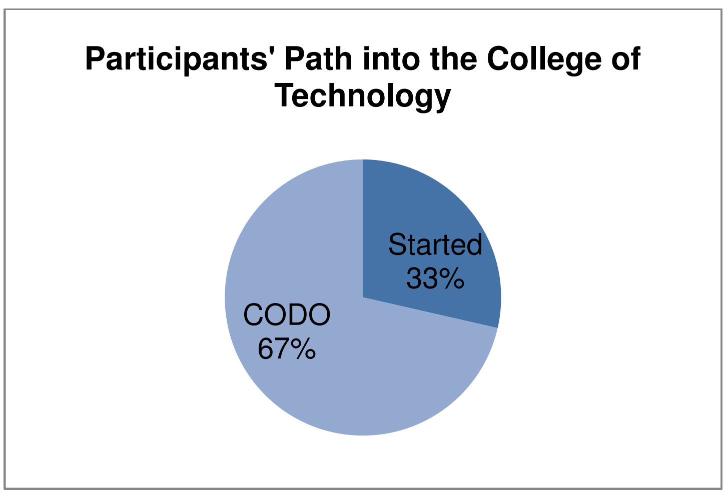

Figure 6. Participants pathways to technology- started or transferred via CODO

Of the 10 students who switched into the College of Technology, four switched from the College of Science, four switched from being undecided, and two switched from engineering.

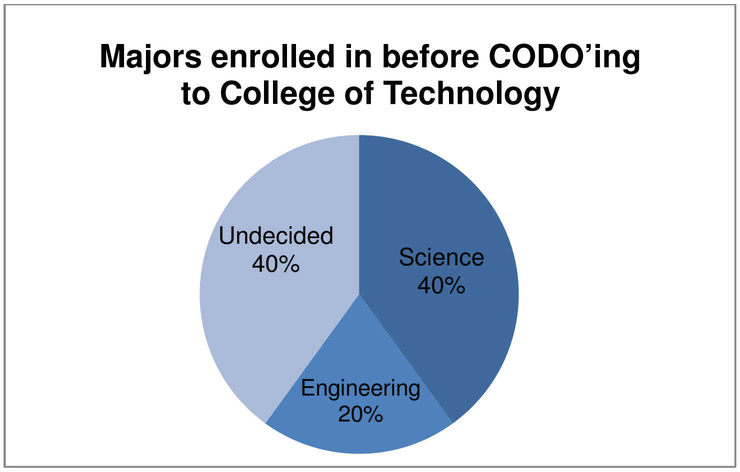

Figure 7. Participants' academics majors before moving into technology

The participants were asked a series of questions pertaining to their academics, self-efficacy, and career aspirations as it pertains to being in the College of Technology. Figure 8 shows the response ratio when the students were asked, "When you first applied to college, did you have an understanding of careers in technology?" Of the 15 students, 13 answered no, and 2 answered yes.

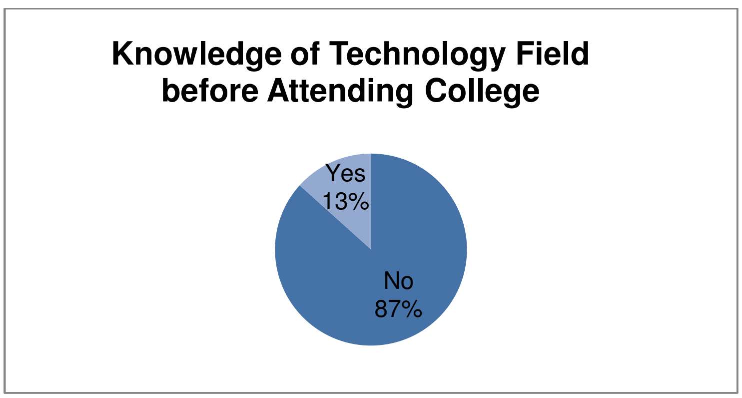

Figure 8. Subjects reporting on understanding of technology before choosing a college major

Listed below are several questions pertaining to the student's self-efficacy majoring in technology, decisions for majoring in technology, and career aspirations once they switched to the technology field.

Self-Efficacy

The following is a list of the most common responses to the question "How would you describe your academic progress once you transferred/CODO into the College of Technology?"

- Academically I am doing the same as I was in Mechanical Engineering, though I enjoy it a lot more.

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- I had a passion for what I was learning, so once I transferred my grades slowly went up.
- My grades improved and I started to enjoy class topics much more.
- I excelled and was able to successfully raise my GPA from 2.5 and graduate with a 3.34
- I would describe my academic progress as successful thus far, even though some classes are quite difficult.
- My academic progress was more successful in the classes that I enjoyed

Decision Factors

The following are paraphrased responses to the question “Why did you choose a major in the College of Technology?” The responses are listed in order of frequency with the highest frequency as the first response:

- More career options in technology
- Stronger interest in course work within Technology fields
- Received knowledge of the departmental area
- Didn’t enjoy engineering field
- Better educational environment between students and faculty

Career Aspiration

The following is a list of the most common responses to the question “How would a greater level of understanding about the career opportunities in the fields of technology have impacted your choice in major?”

- I think I would have explored the college of technology if I had learned a little more about it before getting set in a major
- Heavily impacted me, because many of the careers are ones I would like to have.
- I would have dove into student business and entrepreneurship initiatives in technology far faster.
- I would have just gone into technology and not struggled with the classes in Engineering. My GPA would have also been higher from the start. I wish I would have been explained that they can both get the same jobs.
- I think having more of an understanding would allow students to make better choices upfront, things like which courses to take and how to network in that area, thinking about small choices such as these lead to a better outcome in the long haul; resulting in less time in college meaning less debt

Conclusions

Responses indicated that a lack of knowledge about the technology field was a factor in choosing a major for first-generation college students. The evidence from the pilot study suggests that student's unawareness of technology as a major is a factor in initial decision making when pursuing a STEM-related college education. Students' self-efficacy appears to be closely tied to their GPA and overall performance in the classroom. A better understanding of career placement with respect to options for training and skill preparation could lead students to major in technology. Based on the subject responses, students having a more in-depth knowledge of the academic majors in technology as well as career paths in technology may lead to more first-generation college students completing a STEM degree.

Future Study

Students from peer institutions will be solicited to broaden the subject pool for greater generalizability. Both genders will be sought as participants, despite typical male dominance in traditional STEM fields of study. Female participants in the study may be listed as double minorities by stakeholders and for demographic metrics.

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Biographies

E. SHIRL DONALDSON received a doctorate of philosophy in Industrial Technology from Purdue University December of 2012 and is currently a post-doctoral fellow researching entrepreneurship, project management, and diversity. A strong advocate of inclusionary practices in education and business, she encourages students to work to their strengths while constantly expanding their skill sets and prospective of life. She has mentored several graduate and undergraduate students in areas of progression and transition from undergraduate to graduate studies, research, and study abroad. Her research agenda and commitment to intellectual growth is driven by her life experience. While completing her master's degree and for several years after, she worked in a family owned manufacturing firm. As a doctoral student, Shirl was recognized as an AGEP scholar and received the Bilsland Fellowship. Outstandingly, she collaborated in the creation of an innovation course and taught the initial offering. Today Dr. Donaldson's research interests include entrepreneurship, innovation, technology management, and diversity in STEM (science, technology, engineering, and mathematics) fields of study. She examines how academic and industrial environments enable effective learning, discovery, and realization of new and transferred knowledge.

RYAN N. FAVORS serves as the program specialist for Horizons Student Support Services at Purdue University. His responsibilities are instructing various courses such as study skills for freshmen as well as providing academic assistance to first-generation and/or low-income students. He provides additional support to students by organizing and managing faculty mentoring and tutoring programs. He conducts various study workshops for students in science and math. His focus is on providing the necessary assistance to help students achieve their goals academically as well as in life.Ryan earned his Bachelor of Science from Georgia State University in Atlanta GA; and a Master of Science in Chemistry from Purdue University in West Lafayette, IN. Prior to obtaining his current position with Purdue University, Ryan worked as a geochemist with the National Energy Technology Laboratory in Pittsburgh, Pennsylvania. He spent two years working with the Carbon Sequestration group. His main research area focused on monitoring the absorption of carbon dioxide onto coal seams via infrared spectroscopy.