POTENTIAL FOR WORK-BASED-LEARNING TO BROADEN WOMEN’S PARTICIPATION IN TECHNICAL EDUCATION AND CAREERS: EXPLORATION OF NEW RESEARCH

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ABSTRACT

I. Rationale:

Half of all STEM jobs are available to workers without a four-year college degree, and these jobs pay $53,000 on average—a wage 10 percent higher than jobs with similar educational requirements (Rothwell 2013). Community colleges are the primary institutions charged with training youth and adults to fill sub-baccalaureate STEM positions. They enroll nearly half of the undergraduates in the country, including many low-income and first-generation students, and offer an array of sub-baccalaureate programs with immediate relevance to employment. According to national data, about 85,000 students received two-year degrees in science and engineering in 2012 (National Science Foundation 2014), and community colleges provide STEM education to more than 275,000 students—two-thirds of the size of the four-year college STEM population (Van Noy and Zeidenberg 2014). With their mission of serving local workforce needs, along with their low-tuition, open-access mission, and locations across the country, community colleges have a unique and significant role in STEM education and workforce development. However, data on community college enrollment and degree attainment, particularly within STEM fields, suggests that improvement is needed. Although a substantial share of associate’s degree students enters a STEM field—15 percent in 2011-2012 (National Center for Education Statistics 2016)—the majority end up changing majors or leaving college without earning a degree or certificate (Chen and Soldner 2013). The numbers are even less encouraging for historically underrepresented groups—women and people of color are woefully underrepresented in these fast-growing, high-paying fields (National Center for Education Statistics 2016). Of the students receiving two-year degrees in science and engineering in 2012, for example, 42 percent were female, 12 percent were African-American, and 15 percent were Hispanic—much lower than their overall representation as community college students (National Science Foundation 2014).

Social cognitive career theory (SCCT) provides a useful framework for understanding why students leave STEM fields and, conversely, how to increase the number and diversity of STEM graduates. SCCT combines three interrelated aspects of career development: (1) how academic and career interests develop, (2) how educational and career choices are made, and (3) how academic and career success is obtained (Lent, Brown, and Hackett 1994). SCCT draws heavily from Bandura’s social cognitive theory and focuses on three key concepts: (1) self-efficacy beliefs, (2) outcome expectations, and (3) goals. Self-efficacy refers to an individual’s personal beliefs about his or her capabilities. SCCT assumes that people are likely to pursue and perform better at activities for which they have strong self-efficacy beliefs. Outcome expectations refer to beliefs about the consequences of performing particular behaviors. SCCT assumes that people will follow a course of action if the outcomes of those actions meet positive expectations. Personal goals refer to an individual’s desire to pursue a particular activity or attain a certain level of performance. SCCT assumes that people will follow a course of action if they have a reasonably strong belief that they can achieve their goals. According to SCCT, career decisions and
outcomes do not take place in a vacuum but are hypothesized to be influenced by environmental factors including education and workplace experiences, family, peers, culture, social norms, biases, and stereotypes. In a dynamic process of ongoing feedback loops, students’ choices about education and career are guided by their individual self-efficacy beliefs, outcomes expectations, and goals—factors which, in turn, have been shaped and impacted by the education and workplace experiences they have participated in, along with other external determinants. Positive feedback reinforces goals while negative feedback can lead to changes in education and career goals. (Foley and Little 2015; Lent 2013; Hackett and Lent 2008; Betz and Hackett 2006).

For example, a student might have set a goal to become a computer scientist and work at Google in part because he or she expects this choice will provide a secure, well-paid job doing work they enjoy. At some point, this student likely had some experience with computer science or gateway courses that led them to believe they have the ability to be successful in this field. These expectations, goals, and beliefs could motivate a student to declare computer science as a major and begin the relevant coursework to complete a degree in this field. Once in college, the student might have educational experiences that strengthen their beliefs in their abilities and which further solidify their goals and expectations. In this case, according to SCCT, we would expect that student to continue with their plans, successfully earn a degree in computer science, and apply for a job at Google. On the other hand, the student starting out in computer science might have educational experiences that lead them to question their abilities (e.g., “I failed an introductory course and maybe I’m really not good at coding?”), their expectations (e.g., “there have been massive layoffs of coders so there will likely not be a secure job for me when I graduate college,” “women don’t seem to have much success in this field”), and their goals (e.g., “I am not interested in taking the courses I have to take to earn a degree in computer science, so I no longer plan to work toward earning that degree”).

SCCT has been used extensively within the fields of counseling and career psychology as a method for understanding how individuals develop vocational interests, make occupational choices, and achieve success within their chosen fields. Many studies have focused on operationalizing the framework (e.g., developing reliable and valid measures, testing predictive validity) on an extraordinarily diverse array of populations, for example Taiwanese students; middle, high school, and college students in the United States; science and accounting majors; and employed, underemployed, and incarcerated adults (Johnson 2013; Huang and Hsieh 2011; Soldner, Rowan-Kenyon, Inkelas, Garvey, and Robbins 2012; Luse, Rursch, and Jacobson 2014). Others have focused on using the framework to explore different programmatic, policy, and even parental interventions that might help youth and adults make career choices and find jobs and careers (Sawitri, Creed, and Zimmer-Gembeck 2014; Falco 2017). These studies developed strong and valid measures that have been used to provide support for use of the framework and have used the framework to examine both STEM career pursuit, as well as gaps in STEM pursuit by gender, race/ethnicity and first-generation status. For example, Luse, Rursch, and Jacobson (2014) used the SCCT framework to identify factors that influence high school students to select a major in an IT-related field. Their work found that both interest and outcome expectations have a significant positive impact on choice of major. Rodríguez, Inda, and Fernandez (2016) found similar results studying high schoolers in Spain and tested and found similar results for both boys and girls. In a study of sophomore engineering students, Mercedes, Rodríguez, and Pena (2013) confirmed that the SCCT model produced a good fit to the data across gender, and found women have less self-efficacy beliefs and interest than men. And using the SCCT framework, a recent study found that the relationship between college self-efficacy and college outcome expectations for career aspirations was greater for first-generation college students when compared with their peers (Raque-Bogdan and Lucas 2016).

SCCT provides a lens through which to consider how external conditions, such as social and cultural messages, influence career success, and how these messages might impact pursuit of STEM careers. We know, for example, that students receive different academic, social, and cultural messages about their abilities, the types of outcomes they should expect, and the goals they should set for themselves—and, according to SCCT, these messages have a strong impact on their self-perceptions, goals, and expectations for themselves. For example, girls and women are less likely to see scientists who look like them or have access to peers and mentors to support and encourage them to pursue STEM fields (Buck,
Leslie-Palecky, and Kirby 2002; Riegle-Crumb, Farkas, and Muller 2006; Stout, Ito Finklestein, and Pollock 2013; Eccles and Wang 2015) and have relatively lower self-perceptions of math abilities, which are a key factor behind the gender gap in declaration of a STEM major (Correll 2001). Research by Joy (2014) demonstrated that young women were less likely to enter community college STEM IT and engineering programs because of barriers related to gender and not academics, including isolation as a minority gender in the field, hostile work environments, and lack of access to on-the-job STEM learning. Even when women are interested in STEM, social and cultural barriers can wear away at their self-efficacy and beliefs that the goals of a STEM degree and career are achievable (Nilanjana and Stout 2014; Stout, Ito, Finklestein, and Pollock 2013; Maltby, Brooks, Horton, and Morgan 2016). Similarly, first-generation college students and students from underrepresented minority groups might have limited knowledge of and supports to pursue STEM fields and careers that they might aspire to, given their underrepresentation in these fields. Negatively stereotyped messages about their competencies from other students, faculty, employers, family, and peers, as well as lack of support, might lead students to question their abilities or just not consider setting expectations and goals around STEM-related fields that might seem unattainable (Zirkel and Pollack 2016; Lin 2011; Sackett, Hardison, and Cullen 2004). These messages can be quite powerful and might help explain the enrollment and attainment rates for underrepresented groups described in the opening paragraph. On the other hand, affirming learning experiences in STEM might serve as an antidote to the negative stereotypes that hinder women’s and other underrepresented groups’ motivation to earn a STEM degree (Stout, Dasgupta, Hunsinger, and McManus 2011). Indeed, students that face social and cultural barriers to STEM education and careers might reap the most benefits from experiences that encourage them to believe in their abilities and consider STEM-related expectations and goals.

With regard to positive impactful STEM learning experiences, research suggests that work-based learning (WBL)—defined for this project as an intensive (semester or yearlong) internship, cooperative, or practicum whereby the student earns STEM credit toward their credential or degree on the job, under the supervision of an employer—has the potential to reduce attrition from community college STEM for all students but particularly those who lack social and cultural support for entering STEM fields. While there is no national data that documents the prevalence of WBL in community college STEM, anecdotal and policy evidence suggests that WBL in community college STEM is expanding. For example, 35 states have policies in place to support WBL and U.S. Labor Secretary Acosta recently touted WBL programs, jointly developed by community colleges and businesses, as a critical mechanism to close the nation’s skill gap. In addition, WBL in STEM fields figures prominently in both the National Science Foundation Advanced Technology Education grants and the Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant program.

Research suggests that excellent WBL, which provides authentic work experiences, structured learning activities, and assessment and recognition of skills, increases underrepresented students’ persistence, graduation, and employment rates generally (Rodriguez, Fox, and McCambly 2016). More specifically, by contextualizing learning and skill development within STEM-related employment experiences—providing students with hands-on opportunities to learn about the STEM careers they are training for, access to role models, mentors, broader workplace networks, and, in some cases, compensation—WBL in community college STEM has the potential to improve student perceptions of abilities and influence the self-efficacy, outcomes expectations, and goals of community college STEM students. This approach could hold great promise for women, underrepresented minorities, and low-income and lower-skilled youth and adults, who all too often lack equitable access to high-quality WBL experiences that can serve as stepping-stones to increased economic opportunities (Cahill 2016).

Researchers, the majority of whom have focused on the secondary level, have identified numerous benefits of WBL that align with SCCT’s focus on beliefs, expectations, and goals. Benefits of WBL have included: career exploration, identification development, and planning (Dressler and Keeling 2011; Coll, Eames, and Halsey 1997); postgraduate employment in their field (Drysdale, Goyder, and Cardy 2009); enhanced motivation, attainment, and self-concept particularly in STEM (Brown 2003; Kenny, Walsh-Blair, Blustein, Bempechat, and Seltzer 2010; Coll, Zegwaard, and Lay 2001); and increased work-related competence (Bremer and Mazar 1995; Halpern 2006; Cahill 2016; Salopek 1999; Wiseman and Page 2001).
However, to be effective and ultimately increase the number of STEM graduates, WBL experiences must be designed to positively impact students' beliefs, expectations, and goals (Coll and Zegwaard 2011). For women and underrepresented minorities, this will depend on whether WBL opportunities account for the challenges they face entering STEM fields, including negative stereotypes, lack of support, and isolation in education and work settings. Ensuring WBL opportunities are accessible to underrepresented groups of people, who might not know how to find good opportunities or be given the kinds of supports required to navigate in workplaces where they are a minority, is essential for making sure that WBL expands (rather than diminishes) prospects in STEM fields for underrepresented groups whose prospects have been quite narrow to date.

Despite its prominence and potential, however, little is known about participation in WBL in community college STEM and its impact on certificate or degree completion, or postgraduation STEM employment and education. Also missing is knowledge about how WBL is structured and whether these structures broaden participation or reproduce existing inequalities. Drawing on SCCT theory in this new context of WBL, this study seeks to fill these gaps with research that answers the following questions:

1. Participation in community college STEM WBL:
   a. How does participation in community college STEM WBL differ by student gender, race/ethnicity, and first-generation status, and during economic recessions and expansions?
   b. Why do students participate in community college STEM WBL and what self-efficacy, outcomes expectations, and goal-setting factors influence their selection?

2. Structures of community college STEM WBL opportunities and their alignment to best practice principles:
   a. How are community college STEM WBL opportunities structured?
   b. How do community college STEM WBL structures align with best practice principles as established in the field and by research?
   c. What are the challenges to implementing best practice principles in WBL?

3. Impact of participating in community college STEM WBL on student outcomes:
   a. What are the impacts of community college STEM WBL on student completion of certificates or associate’s degrees, and postgraduate entrance into a STEM career or further STEM education?
   b. Is the impact of community college STEM WBL bigger for historically underrepresented groups (i.e., women, minority students, first-generation students)?

We situate this study in Florida for two key reasons. First, Florida provides a compelling policy context for this study. Florida has a large two-year college system, enrolling more than 800,000 students in 2003-04 in 28 colleges (Florida Department of Education 2005). Florida is one of the 35 states with WBL policies, but one of only nine subsidizing postsecondary instruction and WBL apprentices; Florida exempts students from the requirement to pay fees or tuition in the Florida College System, state university, or school district workforce education program when students are enrolled in a WBL Registered Apprenticeship program (Wilson and Mehta 2017). Florida is also one of the first five states to participate in the Lumina Foundation’s Achieving the Dream: Community Colleges Count initiative designed to increase student success in community colleges. Secondly, Florida leads the country in the comprehensiveness and usability of its state longitudinal database. The state’s data system links comprehensive student and teacher pre-K-12 data with career and adult education (or workforce education), the Florida colleges, and state universities. Included in these data systems are student assessments, student transcripts (with a statewide, common coding system) and employment information. And in our own experience, the Florida Department of Education has been extremely generous and open to sharing the data to support research studies examining STEM outcomes.¹

**Intellectual merits:** Drawing on rich and varied quantitative and qualitative data sources, we will contribute significant new understanding about WBL in community college STEM context, including: who participates in it (and why); variations in the structure and quality of WBL in community college STEM by program area and college; the potential for WBL to broaden participation in community college STEM; and

¹ See Co-PI’s qualifications for list of previous NSF projects and publications using FEDS.
its impacts on completion and postgraduate transitions to STEM careers and further STEM education. This study will also contribute to the field of career counseling research through our application of the SCCT in this new context.

**Broader impacts:** Knowledge from this research on “what works” in community college STEM WBL and “for whom” can be used to support community college development and implementation of more effective and inclusive WBL programs in STEM. By understanding and identifying challenges and opportunities for effective WBL, community college can draw on key findings to build WBL that opens up access to underrepresented groups in STEM (rather than reproducing inequality), improves STEM education and career outcomes for all students, and encourages stronger and collaborative community college employer partnerships.

**II. Data**
We will triangulate and integrate information across three data sources to answer our questions (see Table 1).

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<th>Research Questions</th>
<th>Data Source</th>
<th>Analysis</th>
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| **1a: How does participation in community college STEM WBL differ by student gender, race/ethnicity, and first-generation status, and during economic recessions and expansions?** | • Florida Education Data Systems  
• Community college transcripts | • Phase I (Exploratory and Descriptive Analysis): Map out group differences in WBL participation and build the estimation equations for Phase II and Question 3  
• Phase II (Multivariate Analysis): explore interaction effects between determinants of student selection of WBL |
| **1b: Why do students participate in community college STEM WBL and what self-efficacy, outcomes expectations, and goal-setting factors influence their selection?** | • Program documents  
• Interviews with students, community college administrators, faculty, and WBL employers | • Phase III (from all interviews): explore how individual and external factors as put forth in SCCT interrelate to shape barriers and opportunities for participation in STEM-related WBL by different subgroups |
| **2a: How are community college STEM WBL opportunities structured?** |  | • From administrators, faculty, and employer interviews: inventory of key WBL features, including sectors, hours and intensity, supports, and skills  
• From employer interviews: understand how skills are taught during WBL, communicating progress, and challenges in placing and supporting women and minority students |
| **2b: How do community college STEM WBL structures align with best practice principles as established in the field and by research?** |  | • Map qualitative data on WBL structures to best practice principles for WBL |
2c: What are the challenges to implementing best practice principles in WBL?

- Identify systematic barriers to best practices, including employer policies, course requirements, structural elements, and ineffective counseling strategies

3a: What are the impacts of community college STEM WBL on student completion of certificates or associate's degrees, and postgraduate entrance into a STEM career or further STEM education?

- Florida Education Data Systems
- Community college transcripts
- Interviews with students and community college administrators.

3b: Is the impact of community college STEM WBL bigger for historically underrepresented groups (i.e., women, minority students, first-generation students)?

- Multivariate Analysis: using matched sample, explore impact of WBL on key outcomes and explore interaction effects between determinants of outcomes
- From administrator, faculty, and student interviews: explore how WBL experiences impact self-efficacy, outcomes expectations, goals toward STEM education, and career goals.

All of our data come from the state of Florida. While there are limitations to focusing our analysis on one state—namely that our results are not as generalizable as results that are based on a national sample—what we lose in generalizability, we gain in specificity about the state's population, their education and workforce system, and education and labor market conditions and policies related to STEM. Indeed, the focus on one state will enhance our data analysis. We will use our knowledge of the state's community college system, including STEM and WBL initiatives, to interpret analysis of the Florida state data. Likewise, knowledge gathered through our case study research of two Florida community colleges can be benchmarked against the state data system to explore differences and commonalities.

Data Source 1—Florida Education Data Systems (FEDS): FEDS, which we will use to answer Questions 1a and 3 about WBL participation and impact, is an integrated education and labor market data system that contains information on currently enrolled Florida students from public pre-K through graduate school with individual and school-level data across public schools, community colleges, career and technical education, adult education, and the state university system (Florida Department of Education 2017a). Post-school employment and non-education system program data are available as well. Because the data have been collected over time, we can examine the uptake and impacts of WBL during two different time periods; the recession of 2007-2012 and the expansions of 2013-2018. We have prior experience successfully obtaining permissions to use FEDS data and have experience analyzing these data. Toward that end, we have included at the beginning of the research timeline six months to work with the Florida Department of Education to obtain a memorandum of understanding to work with the data and are confident, from conversations we have had with officials, that they are eager to work with us to secure use of the data for this research project.

We will draw from this rich longitudinal data set key variables for our analysis of WBL, including: student demographics, high school and college transcripts (courses, grades, and semesters attended), industry-related credentials earned in college, transfers between colleges, and transition from college to careers. Importantly for our research purposes, the data track whether or not students participated in a WBL experience while in college, defined as "a cooperative education course whereby the student, by written cooperative arrangements between the school and employer, is employed and receives compensation, and receives instruction, including required academic courses and related vocational instruction" (Florida Department of Education 2017c).

We will conduct our analysis on two cohorts of data to address Questions 1a and 3a-b—who participates in WBL and is WBL beneficial? Cohort 1 includes students who attended a Florida community college
between 2008 and 2012 during the Great Recession, and Cohort 2 includes students who attended a Florida community college between 2013 and 2017 post-recession (National Bureau of Economic Research 2010). With these two cohorts, we can compare incidence and outcomes of WBL during a recession versus post-recession. There are several reasons that both the participation in and outcomes of WBL might vary, depending on the strength of the labor market. During the recession, community colleges experienced an increase in enrollment from students who were displaced from the labor market seeking retraining, and also from traditional-age students who could not afford a four-year degree (Dunbar, Hossler, Shapiro, Chen, Martin, Torres, Vasti, and Ziskin 2011). Enrollment numbers have since declined, post-recession, as the economy has moved into recovery and labor market opportunities have increased (Smith 2016). As a result of the qualitative difference in the kinds of students attending community colleges during and post-recession, along with differences in enrollment sizes, we might expect to see differences in student participation in WBL—both overall uptake and characteristics of students participating. On the employer side, during a recession when labor market demand is falling, employers might be less likely than during periods of growth to offer WBL opportunities. In many cases, employers utilize WBL opportunities when entry-level and middle-skill jobs are hard to fill in order to build a skilled applicant pool (Struck 2009). In addition, with fewer job openings during the recession, students may find it harder to find employment postgraduation than during a period of growth (potentially impacting a key outcome variable that is external to the impact of WBL on entering a STEM career). While these data will not allow us to tease out the separate supply-and-demand-side effects of the recession on WBL incidence and outcomes—nor is this a key question of our analysis—pooling the data across recessionary and post-recessionary time periods could confuse an analysis of the incidence and outcomes of WBL. Thus, we will conduct the analysis for the two different cohorts. By doing so, we are not only able to analyze more data points, but we will also map out differences in the incidence and outcomes during a recession and post-recessionary period.

Preliminary analysis of the data show that there are sufficient numbers of students participating in community college STEM and WBL for us to conduct our analysis. In particular, during the 2011-12 school year—the latest year data are publicly available—there were 1,733 students majoring in community college STEM. Seventeen percent of these students participated in WBL. Over a five-year cohort, we could expect our sample to include a total of 8,665 community college STEM students with 1,500 having participated in a WBL course. For reference, more than 70,000 students earned associate of arts or sciences degrees in Florida in 2015-16, and about 35,000 earned vocational or college credit certificates (Florida Department of Education 2017b). We will use FEDS to understand who participates in community college STEM WBL by different student characteristics, and the impact of WBL on STEM program completion and postgraduate transitions to STEM careers and further STEM education. Further, since our analyses will be conducted over the two cohorts, we will explore how participation and impact of WBL in community college STEM differs during periods of economic contraction and growth.

Data Source 2—Case study of WBL in STEM at two Florida community colleges: To gather information to address Questions 1b and 2a-c about student participation in WBL, and the structure and quality of WBL available in community college STEM programs, we propose collecting documents and conducting semi-structured interviews of students and staff at two Florida community colleges, soliciting information about how students learn about WBL; what influences choices to participate in WBL (if they had a choice); if/how WBL influences their self-efficacy, goals, and expectations (per SCCT); and perceptions of if/how WBL improves students’ outcomes. In addition, we will analyze extant data from the colleges to more deeply explore the impact of WBL experiences on student completion of STEM programs of study, and postgraduate entrance into STEM careers and four-year STEM programs of study (Question 3).

Both Broward College and St. Petersburg College have agreed to participate as case study schools for our project (see attached Letters of Agreement to Participate). We chose these colleges because they have nationally recognized STEM programs with WBL offerings and large numbers of diverse students enrolled

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2 Community college STEM fields in our study include: physical and natural sciences, mathematics, IT, engineering, and engineering technologies.

3 Documents to include: college reports on WBL opportunities, experiences, and outcomes; training materials for participating WBL employers; relevant career counseling materials.
and completing degrees and/or certifications. For both colleges, we are focusing our case studies on the IT and engineering technology (ET) programs. By narrowing our focus on two STEM majors, we have the opportunity to draw a deeper and more comprehensive understanding of who participates in WBL, how it is structured, and outcomes than we would have if our case study analysis were spread over many different STEM majors. This mitigates some of the variability in how WBL is approached and embedded into the curriculum across STEM disciplines. We chose IT and ET because: (1) these are two of the largest STEM disciplines and will give us a large sample to analyze and, (2) WBL is a major curriculum component in both of these fields. These majors also offer students the opportunity to earn a credential—terminal associate’s degree or transfer associate’s degree—which will enable us to examine participation and impacts of WBL in all contexts.

**Broward College.** located in Fort Lauderdale, is a large and diverse urban college with a total enrollment of 62,508 students, 66 percent of which are underrepresented minorities. In 2017, they were one of 10 finalists (out of 1,000 community colleges) for the prestigious Aspen Community College Prize, which is given every two years to a community college that has shown national excellence in four areas: student learning, certificate and degree completion, employment and earnings, and high levels of access and success for minority and low-income students. After graduating from Broward, students attain bachelor’s degrees at a rate that is 50 percent higher than the national average, and there is virtually no gap in three-year graduation/transfer rates between all students and their underrepresented minority students (46 percent). WBL is a mandatory course for IT students but voluntary for ET students.

**St. Petersburg College.** located in St. Petersburg, is also a large and diverse urban college serving 65,000 students from 100 different countries. As a leader in STEM education, St. Pete is part of a structured, funded grant from Helmsley to build out STEM guided pathways that are inclusive of WBL. Winning the grant demonstrates St. Pete’s financial, policy, and staff commitment to STEM education. During the 2016-17 school year, 304 students were enrolled in ET, including 82 percent men and 16 percent white students. During the same year, 1,502 students were enrolled in their IT programs, including 89 percent men and 62 percent white students. Nineteen percent of the ET students had completed a voluntary WBL and 10 percent of the IT students had completed the mandatory WBL course.

**Interview sample (N is total for both community colleges):**
1. Students: *Total of 60*
   - 20 students at each community college who participated in WBL (10 from IT, 10 from ET)
   - For ET program where WBL is voluntary—10 students from each school that did not participate in WBL
2. Administrators: *Total of 6*
   - Deans of IT and ET at both schools
   - Coordinator of internships/cooperatives at both schools
3. Faculty: *Total of 24*
   - At each school, 4 faculty in IT and 4 faculty in ET
   - At each school, 4 faculty in math who teach IT or ET students
4. Employers: *Total of 48*
   - At each place of employment (6 from IT and 6 from ET), two employees: manager responsible for overseeing the WBL and the staff supervising students

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4 Students will be recruited to participate in interviews through faculty and research staff presentations in upper-level IT and ET courses since the WBL is typically taken during the last year of study. Students will be offered a $25 gift card to participate in a one-hour in-person or phone interview.
5 Faculty recruited with the assistance of deans and department chairs will be offered a $25 gift certificate for their participation in a one-hour in-person or phone interview.
6 Included in our interviews will be some of the employers where student interviewees have participated in (or are participating in) WBL in order to be able to match information from students with those from employers.
As discussed in section III, we will analyze the interview data to answer Questions 1b and 2a-c, and use analysis to add context to the discussion of results from the quantitative analysis conducted for Question 3.

**Data Source 3—Student transcript data:** To further explore participation in WBL and the impact of WBL on STEM program completion, postgraduate STEM employment, and transfer to four-year STEM programs of study (Questions 1a and 3), we analyze student transcript data and postgraduate employment, and transfer information from all of the IT and ET students at our case study schools. This community college-level data will be drawn at the end of fall semester for each of the three years of study. Analysis of community college-level student data will allow us to replicate and extend the participation and impact analysis that we are conducting with FEDS. There are three major differences between how WBL is measured in FEDS and in the student transcript data, and we plan to exploit these differences to deepen our understanding of WBL participation and impacts. First, unlike the student transcript data, in FEDS, we cannot tell whether the WBL was mandatory or voluntary. Second, FEDS data counts only WBL that is paid, whereas WBL at the case study schools can be paid or unpaid. Third, in FEDS, we do not know which STEM field the WBL was in, but with the community college-level transcript data, we can identify the STEM field of the WBL. Student transcript data obtained directly from the community colleges will allow us to explore with more nuance which kinds of WBL students participate in and which have the most impact on outcomes. Finally, we can utilize information about the quality of the WBL experience in each program and school to help interpret these quantitative findings from the participation and outcomes analysis.

**III. Methodology**

**Question 1: Participation in community college STEM WBL**

a. How does participation in community college STEM WBL differ by student gender, race/ethnicity, and first-generation status, and during economic recessions and expansions?

b. Why do students participate in community college STEM WBL and what self-efficacy, outcomes expectations, and goal-setting factors influence their selection?

**Phase I—Exploratory and Descriptive Analysis:** To answer question 1a, we draw from the two cohorts of community college STEM students from FEDS, including: (1) recession cohort 1 (2008-2012), and (2) post-recession cohort 2 (2013-2017). We anticipate a sample size of approximately 8,600 community college STEM students with 17 percent having participated in a WBL course. We propose beginning by exploring the data for differences in WBL participation by student demographics, STEM major, prior STEM academic achievement including high school and community college STEM courses and grades, semesters of college attended and gaps in attendance, transfer between colleges, certificate or associate’s degree pathway, and student financial circumstances. This exploratory analysis of the FEDS will allow us to map out—and test for significant differences between—group differences in WBL participation and to build the estimation equations for the next phase multivariate analysis and the outcomes analysis discussed below. For these and all quantitative data analyses, any missing data issues that may arise will be addressed in a way that minimizes bias, maximizes the use of available information, and allows for good estimates of uncertainty (Enders, 2010). Multiple imputation procedures will be used if needed, in part because the researchers are familiar with the approach (Enders, 2010).

**Phase II—Multivariate Analysis:** For the logit analysis, the binary dependent variable is equal to one if the student participated in WBL and zero otherwise. Key independent variables include controls for the individual and external factors that research suggests are expected to influence student participation in WBL, including: gender, race/ethnicity, being a first-generation college student, STEM field, semesters completed, high school GPA in STEM content areas, high school WBL experience, college STEM courses and grades prior to WBL, certificate / associate’s degree pathway, and current employment status. As the data allow—which we determine in the exploratory phase of data analysis—we will run this regression in multiple ways, including pooled and unpoled by gender, race/ethnicity, and certificate or associate’s degree program to explore interaction effects between these variables and other determinants of student participation.

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7 For contrast and comparisons, we will also explore participation of WBL with the student transcript data from the case study schools.
selection of WBL. If the data allow, we will also exploit the panel structure of the data. A benefit of the panel structure of the data is that it allows us to account for individual factors that influence a student’s participation in WBL that are interrelated with the independent variables in the model, but are unobservable to the researchers.

Results from the regression analyses will answer the question of who participates in WBL and delineate significant gaps in participation by key groups and factors. While the quantitative portion of this analysis allows us to determine who participates in WBL, the next qualitative phase of analysis allows us to explore why students participate in WBL and how participation differs by groups. It is through this qualitative analysis that we conduct an explicit investigation of how the SCCT factors of self-efficacy, outcomes expectations, and goals, along with environmental factors, influence WBL participation.

**Phase III—Qualitative Analysis:** To answer question 1b, we will conduct semi-structured interviews with students, faculty, and employers associated with IT or ET at the two Florida community colleges. Interview protocols will be adapted from instruments developed by researchers using SCCT to study the impact of a minority teacher recruitment program for urban and rural minority students (Schaffner and Jepson 1999). The researchers' instruments measured self-efficacy, outcome expectations, and interest as they relate to becoming teachers; we will adapt these measures to relate to STEM careers. Our interview protocols will solicit information on factors that potentially influence student selection of an internship, including knowledge and availability of WBL, ability to fit WBL in with other academic and non-academic demands, and having adequate prior academic preparation to participate in WBL. Specifically, we will ask community college STEM students questions about why they selected (and why they didn’t) to participate in WBL, and probe about feelings of self-efficacy, expectations, and goals; which semester they made their decision; who helped them make the decision (family, friends, employers, faculty, career counselors); courses, if any, that influenced their decision; and any factors including negative stereotypes that made participating in WBL challenging or limited WBL opportunities. For all students (those who voluntarily chose WBL and those who were mandated), we explore their selection of the particular WBL that they participated in, including what opportunities they were most attracted to, what opportunities were available to them and which they were not able to take advantage of and why, who helped them make their decision, and when, in their educational pathway, they made the decision to participate. We will also explore challenges to participating, if any, and how they were overcome.

We also use semi-structured interviews with faculty and employers soliciting information about how they support student selection of a WBL experience, challenges that students face finding and participating in WBL, and what elements make the WBL a good match for students. From employers, we will gather information on how they select students for their programs to see if there are external factors in WBL structure that makes participation for certain groups (related to student demographics, financial background, or academic background) more difficult than others. For example, are employers able to accommodate flexible scheduling that students with children may require? In these questions, we will explore how gender or racial stereotypes held by faculty or employers might influence the WBL available to students, mentoring, or education and career advice. If baseline skills are required for the WBL, we will explore assessments and their basis (grades, courses completed, problem-solving during interviews).

In this qualitative analysis, we can explicitly analyze how student self-efficacy, outcomes expectations, and goals, and the external environmental factors that influence them, work together to shape student participation in WBL—both the decision to participate and the kinds of opportunities that are selected. This

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8 With five years of data for each cohort, some students will appear more than once within each cohort of data. To exploit this panel structure of the data, we require enough variability in the independent variables over time—variables that change over time, like number of credits earned, STEM GPA, semesters attended—to estimate group, individual, and time-varying effects on participation of WBL. If the data allow, we can also explore within-school effects, since we have information on the community colleges that students attended.

9 Questions about why they participated are relevant only to those ET students for whom WBL is voluntary, while questions about the kinds of WBL selected will be asked of both the IT and ET students.
portion of the research will allow us to explore how factors as put forth in SCCT interrelate to shape barriers and opportunities for STEM-related WBL by different subgroups.

**Question 2: Structures of community college STEM WBL opportunities and their alignment to best practice principles**

2a: How are WBL opportunities structured?
2b: How do WBL structure align with best practice principles as established in the field and by research?
2c: What are the challenges to implementing best practice principles in WBL?

An underlying component to answering these questions is identifying guidelines for best practice principles in community college STEM WBL. While no research to date exists—a gap we will begin to fill with our research—we can build on the work Jobs for the Future (JFF) has done with more than 30 years of experience working with community colleges on education and workforce development, including developing best practice principles in WBL (Cahill 2016). The seven best practice principles developed by JFF include: supporting entry and advancement in a career track; providing meaningful job tasks that build career skills and knowledge; offering compensation; identifying target skills and how gains will be validated; rewarding skills development; supporting persistence and completion; and providing comprehensive student supports. In the early phase of our project, we will add to these seven characteristics of effective WBL with principles specific to WBL in community college STEM fields through an extensive review of the literature and initial conversations with our advisors and other leaders in the field.

To answer question 2a, we draw from our interviews with WBL administrators, faculty, and employers about the structures of WBL opportunities that students in IT and ET participate in. Since students participate in WBL from a large number of employers—more than we can feasibly interview individually for this study—information gathered from community college administrators and faculty will focus on the range of key WBL partnerships that students in each program have participated in during the last five years. Questions that pertain to the range of WBL structures will be organized by the seven best practice principles, including: (1) range of sectors and the functional departments that students have exposure to; (2) typical hours worked per week in the WBL; (3) the supports the college and employers provide while students are participating in the WBL, which may include transportation, child care, and managing schedules; (4) integration of skills developed in courses with those gained in the workplace; and (5) any post-WBL assessments that are conducted including industry-based credentials. From this information, we will be able ascertain how WBL is structured across a range of different opportunities.

We will also gather more specific data about WBL structures from the 12 employers (from each school) we plan to interview. As noted above, our employer interviews will include those companies where student interviewees have participated in WBL so we can link responses. More specific information about the structure of the WBL—organized around the seven basic principles—will be collected from the 12 case study employers from each school, including: (1) how hours spent in WBL are distributed between activities like job shadowing, skills development, and cross-function workplace exposure; (2) how skills are taught and assessed on the job and by whom; (3) number and content of meetings with mentors and role models; (4) student supports; (5) ways in which faculty and employers communicate about student progress; and (6) challenges, if any, in placing women and minorities in workplaces where they are underrepresented.

To answer question 2b, we will code data using the best practice principles of WBL and map the overlap between the structural elements of WBL available in the IT and ET programs at each school to best practice principles of community college STEM WBL developed in the early stages of research. We will conduct member checking to fill in any gaps we may have missed during the interviews (Cresswell 2007). These analyses will shed light on the range of quality of WBL that is available to students at the two community colleges in our study by field, and very specific information about quality for the 24 workplaces included in

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10 The number of participating employers varies by school and program. For example, At St. Petersburg College, there are over 100 participating WBL employers in IT and close to 50 in ET.
11 Along with others we add during the research process.
our interviews. We will further link information about WBL quality by specific employer to the relevant student interviews to explore relationships between gender, race, financial, and academic background to see if there are patterns in the quality of WBL experiences that different students have access to.

For question 2c, we draw from interviews with community college administrators, faculty, and employer partners about challenges to implementing the best practice principles in WBL in their schools and in their places of employment. These questions will explore such challenges as: (1) company policies that restrict a more effective WBL structure; (2) course requirements and sequencing that limit when students can participate in WBL; (3) lack of formal structure in college employer partnership that makes closer collaboration difficult; (4) effectiveness of career counseling strategies for different groups of students.

Methods of Qualitative Data Analysis: Interviews will be recorded, transcribed, and coded using ATLAS.ti, a commonly used qualitative data analysis software. For coding of interview data, we will create a “start list” of predefined codes and additional codes will be added as necessary and appropriate. The list of predefined codes will be informed by literature on WBL. Two researchers will conduct independent coding of interview transcripts and identify consistent themes and categories using qualitative software (e.g., ATLAS.ti or NVivo). Researchers will also keep analytic memos to document reflections on their coding processes and code choices and any emergent patterns or themes throughout the coding/analysis process (Saldana 2016). Differences in analyses between the two researchers will be reconciled through discussion before finalizing the analyses, and data collected from interviews will be synthesized to create a “thick description” in order to best address the research questions posed in this study (Cresswell 2003; Lincoln and Guba 1985). The credibility of qualitative analyses will be checked using standard procedures such as cross-method and cross-information triangulation of findings, negative case analyses (i.e., explicit search and explanation of discrepant information), careful documentation of records, review of extant data sources such as print materials, and checking with select stakeholders. Once this is complete, resources will be directed toward analyses of data, which will include both thematic and content analyses.

Also, to confirm the interviewees’ responses are accurately reflected in the report, a member checking process will be executed by sharing the draft manuscript with a small group of randomly selected interviewees. Informants will be asked to review the draft manuscript and note any discrepancies, inaccuracies, or changes made to the policies or plans since the interviews.

Question 3: Impact of participating in community college STEM WBL on student outcomes
3a: What are the impacts of community college STEM WBL on: (a) student completion of certificates or AA degree, and (b) postgraduate entrance into a STEM career or further STEM education?
3b: Is the impact of community college STEM WBL bigger for historically underrepresented groups (i.e., women, minority students, first-generation students)?

To answer Questions 3a and b, we draw from the two cohorts of FEDS, student transcript data, and student, faculty, and employer interview data.

Florida State Data: We begin by creating a matched sample of non-WBL participants to compare with the sample of WBL participants. To that end, we use propensity score matching based on potential covariates identified in descriptive analyses—for example, differences in high school GPAs between WBL and non-WBL students (Rosenbaum, Rubin, and Donald 1983). Once the matched sample is created, we will separately estimate the impact of participation in WBL on certificate or associate’s degree completion and postgraduation entrance into a STEM-related career or four-year STEM degree program. For completion of a community college STEM program, the sample will consist of students who have completed at least four semesters of college to ensure that they have had a minimum amount of time to earn a certificate or associate’s degree. We will estimate the model separately by certificate and associate’s degree if the sample size permits, otherwise we will conduct the estimation pooled with binary dummy variables for certificate or associate’s degree pathways. We will conduct the estimation with two different dependent variables. For the binary logit estimation, the dependent variable is equal to one if the student completed a program and zero otherwise. For the multinomial logit, the dependent variable is equal to one if they completed the program, two if the left college prior to completing, three if they are still enrolled. The key independent variable is whether or not they participated in WBL with other control variables aligned
with factors hypothesized in the SCCT model of career selection, including: student demographics, STEM grades, gaps in community college attendance, and semesters attended. Since the impact of factors may vary by gender and race/ethnicity, we will also run the estimations with these interactions’ effects.

For postgraduate entrance into a STEM job or four-year STEM degree, the sample will be restricted to students who have completed a certificate or associate’s degree. Once the matched sample is created, we will estimate the model separately by certificate and associate’s degree if the sample size permits, otherwise we will conduct the estimation pooled with binary dummy variables for certificate and associate’s degree pathways. The model will be estimated as a multinomial logit with the dependent variable equal to one if the student entered a STEM related career, two if they entered a STEM related four-year program, three if they were employed in a non-STEM field, and four if they were unemployed or out of the labor force. The key independent variable is whether or not they participated in WBL, with other independent variables included to capture factors delineated in the SCCT model of career selection, including: student demographics, STEM grades, gaps in community college attendance, and semesters attended. Since the impact of factors may vary by gender and race/ethnicity, we will also run the estimations with these interactions’ effects.

**Student Transcript Data**: We will replicate the estimations conducted with FEDS with student transcript data from the two participating community colleges. Matched samples will be constructed, and the dependent and independent variables will be the same as those used in the above estimations using FEDS. Because WBL is measured with more nuance in the transcript data—allowing for both mandatory and voluntary WBL, paid and unpaid WBL, and the STEM WBL field—these estimations will enable us to deepen our understanding of how different kinds of WBL impact outcomes.

**Interview Data**: For those students who participated in a WBL experience, we will examine how the quality of that experience, as derived in Question 2b, is related to their completion of a certificate or degree and postgraduate entrance into a STEM career or four-year program of study. Specific questions we will ask to gather this information include: What courses best prepared them for the WBL experiences? What skills acquired through WBL helped them to complete additional STEM coursework and make progress toward degree completion? How did their WBL change or confirm their future education and career goals? Did mentorship or role models from WBL assist them in their certificate or degree completion or postgraduate education and career goals? We will also gather information about student outcomes from their faculty and employer supervisors/mentors to ascertain their perspectives on how the WBL did, or did not, support student completion of post-WBL STEM courses, progress toward completing the certificate or associate’s degree, and goals in meeting future STEM career and education goals. We plan to analyze the data as described under Question 2 using the SCCT framework of self-efficacy, outcomes expectations, goals, and environmental factors as we code, analyze, and examine relationships in the data.

**Research summary**: Drawing on several rich and varied quantitative and qualitative data sources, these analyses will provide substantial new understanding about who participates in WBL in community college STEM and why, variations in the structure and quality of WBL in community college STEM by program area and college, and the impact of WBL on postgraduate entrance in community college careers and further education. The qualitative and quantitative analyses complement each other. The large and longitudinal FEDS data will allow us to map out correlations by groups in participation and impact across the state at two different points in time—information that is not currently available in the research. To complement this state-level map of participation and outcomes, the qualitative analysis allows for a deeper and more focused exploration of the relevance to WBL of specific SCCT factors hypothesized to shape students’ education and career choices, including self-efficacy, outcomes expectations, and goals and environmental factors. WBL in community college STEM has expanded in recent years because it has the potential to improve community college STEM education and career outcomes. Whether or not WBL makes these positive impacts for all students—including women and minority students who have been persistently underrepresented in these fields—however will depend on student access to WBL opportunities, supports prior and during WBL, the structure of the WBL, and the integration of WBL with the STEM curriculum—all factors we explore in our qualitative analysis.