Evaluation of Ivy Tech's Pathways to Information Technology: Implementation and Outcomes, Final Report

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I. INTRODUCTION

In 2014, Ivy Tech Community College began implementing a set of reforms in its Information Technology (IT) programs.[1] These reforms were supported by a $2.5 million U.S. Department of Labor TAACCCT grant aimed at updating the college's computing programs. TAACCCT grants aim to strengthen community colleges' ability to meet workforce needs through "advancing innovative, sector-based system change in regional and statewide economies" with the goal of "creating industry-driven strategies that are responsive to regional labor markets and state economies" (U.S. DOL, 2014).

The grant activities, which sought to strengthen and support a reorganization of Ivy Tech's computing programs that had occurred separately prior to the grant, were motivated by larger efforts centered on better aligning programs with labor market needs and improving the clarity of student pathways. These activities included the purchase of supplies to support hands-on learning; the addition of professional development opportunities for faculty; the redesign or enhancement of program pathways; the development of a student advising tool and student competitions; and the expansion of employer outreach and connections with the workforce system. Through these activities, Ivy Tech sought to strengthen its computing program statewide and to improve the retention, completion, and employment outcomes of its computing students.

A team of evaluators from the Education and Employment Research Center (EERC) at Rutgers, The State University of New Jersey, worked with Ivy Tech throughout the grant period to conduct a comprehensive evaluation of this TAACCCT implementation. The evaluation utilized a mixed methods approach to gather data from multiple perspectives on grant implementation and outcomes. In this report, the last of three evaluation reports on the project, we discuss the final implementation efforts of grant activities at Ivy Tech and examine lessons learned and prospects for sustainability. We present information on the characteristics of students enrolled in computing programs during the grant period and examine their outcomes in classes affected by grant-purchased supplies and hands-on learning reforms. We also discuss student pathways in computing programs and conduct a quasi-experimental analysis of the grant activities.

The report begins with a section in which we describe the qualitative and quantitative methods used in the evaluation. Subsequent sections of the report include findings on student characteristics, student outcomes, implementation updates on hands-on learning, faculty professional development, advising, employer engagement, and student competitions. The report concludes with an overall discussion of lessons learned and recommendations.

[1] Until reforms that took place shortly before the grant period, these programs had been referred to as Computing and Informatics, or CPIN, programs.

II. METHODS

Members of the EERC evaluation team conducted site visits and telephone interviews, examined existing program documents, administered online surveys, and analyzed administrative records of students enrolled at the college. In this section, we describe each of these data sources and how it is used in our analysis.

Site Visits and Interviews

We conducted one-day site visits in November 2017 at two different Ivy Tech campus locations – Gary and Valparaiso. Over the course of these site visits, we conducted two student focus groups and interviewed three faculty members and an advisor. During the same period, we conducted telephone interviews with two additional advisors, five faculty champions, two central college staff, and four staff members representing the campuses of Franklin, Richmond, Noblesville, and Sellersburg. All interviews were recorded and transcribed. Interview transcriptions and notes were coded using NVivo qualitative data management software and then analyzed by EERC team members.

Document Review

The qualitative analysis in this report includes a content analysis of Ivy Tech's goals and activities. This analysis was based on the college's grant reports filed with the U.S. DOL; our communication with the campuses; internal presentations and planning documents; notes and minutes from meetings; spreadsheets for tracking supply purchases and implementation; spreadsheets for tracking professional development; and the college website. Documents were coded using NVivo and analyzed by EERC team members.

Survey Data

The evaluation team developed three surveys that were administered to groups of students and faculty members in the School of Information Technology across all Ivy Tech campuses. These included a student survey for all IT students, a hands-on learning survey for a targeted subset of students in classes that emphasized use of the supplies purchased under the grant, and a faculty survey for IT faculty. Surveys were fielded once for the first evaluation report, referred to as "Round 1" surveys, a second time about one year later, referred to as "Round 2" surveys, and a third time the following year, referred to as "Round 3" surveys. The surveys included many of the same questions. Appendix A includes a detailed table that summarizes the sample sizes, response rates, timing, and average length of each survey.

The *Round 3 School of Information Technology Student Survey* was aimed at all students enrolled in any IT class and was designed capture the information needs and decision-making processes of a wide range of students with regard to the college's IT programs and related careers; their experiences with academic advising; their current employment situation; and their

potential interest in internships. This general survey was fielded between January 2018 and April 2018.

The survey was closed at the beginning of April 2018. For our final analysis, there was a total N of 804 students that provided valuable data across all surveys administered. The students to whom the survey was administered were identified with the assistance of the Ivy Tech institutional research department.

The other general survey, referred to as the *Round 3 School of Information Technology Faculty Survey*, was fielded by the EERC in January 2018 and targeted all faculty teaching courses in Ivy Tech's School of Information Technology IT programs statewide. The list of faculty members to whom the survey was sent was provided by the TAACCCT project director. Reminders were sent to potential respondents three times during the months of January and February. The survey collected information on faculty members' use of supplies and hands-on learning; perceptions of students' information needs; decision-making processes regarding the School of Information Technology programs and related careers; and experiences with employer engagement. Our final analysis includes a total N of 46 faculty.

This report also refers to survey data collected in early 2016 for EERC's first evaluation report, published later the same year. The first student survey, referred to as the *Round 1 CPIN*[2] *Student Survey*, was fielded in February 2016 and targeted all students enrolled in any CPIN class. The first faculty survey, referred to as the *Round 1 CPIN Faculty Survey*, was fielded in March 2016 and targeted all faculty teaching courses in the CPIN program statewide. These two surveys mirrored their Round 2 counterparts relative to the information they were designed to glean from respondents. Survey data were collected using Qualtrics and analyzed using Stata data analysis and statistical software. Percentages from survey responses may not equal 100 due to rounding.

Student Administrative Records Data

Student administrative records were provided by Ivy Tech's Institutional Research Central Office. Data collected from the records included student demographics, enrollment status, course history, credential completion, and wage records from Fall 2014 through Fall 2016. The EERC data administrator de-identified all data files before they were made available to the EERC evaluation team for analysis. Information on campuses, programs, courses, and curricula were provided by the TAACCCT project director in various formats and incorporated into student data files as needed. From combined data, we derived several key indicators, including the School of Information Technology and comparison program groups, retention across terms, credit earning, and major-area milestone completion. These data inform both our

[2] The School of Information Technology was previously referred to as Ivy Tech's Computing and Informatics programs; Ivy Tech created a separate school to house the programs in 2017. Therefore, EERC's first two rounds of surveys were referred to as CPIN surveys.

analyses of overall grant impact, instructional format, and student pathways as well as our quasi-experimental comparison of TAACCCT students with students in other Ivy Tech programs.

III. IMPLEMENTATION UPDATES AND SUSTAINABILTY

In this section we present detailed updates of the implementation efforts that were continued during the fourth and final year of the grant period. Most implementation during this period continued work from previous years. For example, implementation continued relative to hands-on learning, industry certification training, advising, employer engagement, and information technology competitions. Each is discussed in turn below. Sustainability of each activity is discussed within each section.

Hands-on Learning

A continued priority in Ivy Tech's implementation of its TAACCCT grant was to increase the amount of hands-on learning in its CPIN programs through investment in updated equipment and supplies. The college sought to ensure the programs at each campus had proper industry-standard equipment and supplies to work with so that faculty could provide students with the skills and abilities necessary for their careers. Programs also gained control of a local computing network to use for instructional purposes. Faculty were trained on the new equipment and were offered industry certifications as part of the implementation.

This section is a continuation of work begun in the interim report[3] as campuses continued to implement their hand-on learning goals established for the grant period. A few campuses continued to build programs and technological infrastructure during the final year of the grant, but most worked on continued implementation in the classroom setting. This section discusses several aspects of reforms that occurred during the final year of the grant that were aimed at promoting hands-on learning, including the continued installation of purchased equipment and supplies at some campuses. It also discusses faculty reports of the impact of the equipment, supplies, and network control on their teaching during the final year of the grant, and student reports of the impact of hands-on learning on their education experience.

Continued Installation of Supplies

Installation of equipment and supplies has been an ongoing process throughout the grant period. During the first three years of the grant, 18 campuses received at least modest new IT lab spaces; ten of these received full labs. An additional ten campuses received foundational or intermediate data centers. Over the final year of the grant, five additional labs were either updated or newly created. The TAACCCT grant was a major investment for Ivy Tech in terms

[3] See Edwards, Douglas, Van Noy and Vinton. (2017). *Evaluation of Ivy Tech's Pathways to Information Technology: Implementation and Outcomes, Interim Report #2*. Piscataway, NJ: Education and Employment Research Center.

of updating lab, equipment, and supply needs across the state, but campuses were still "uneven" in what they could offer students. A primary focus of grant management during the final year of the grant was to create equal capacity across campuses. Another change in focus involved a shift away from infrastructure, which was upgraded early in the grant period, toward a final assessment of resource needs for optimal classroom integration of hands-on learning.

Figure 1: Process for expanding opportunities for hands-on learning.

Specifically, grant activities late in the grant period included the addition of more equipment or supplies (on some campuses) and classroom integration, including a focus on fine-tuning classroom space for student use of the new equipment. For instance, one of Ivy Tech's IT courses requires three separate workstations for each project as the students must work in groups of three to complete the course. Many campuses were not able to successfully set up this arrangement prior to TAACCCT. Some colleges had issues getting enough equipment and supplies to successfully create this set-up, while others had difficulty finding enough space to implement the changes. During the final year of the grant, effort was put into making sure most campuses could properly set up their student space to allow for the three workstations and to optimize the classroom setting for hands-on learning at all campuses.

In addition to establishing the three workstations, some campuses were working on increasing program capacity from 10 to 20 students during the final year of the grant. This would help with enrollment capacity and long-term sustainability. One campus reported that proper supplies (such as racks and towers) allowed for more efficient classroom learning as students now had adequate space to complete tasks without being impeded by obstacles such as "having things on tabletops stacked against one another." However, other campuses indicated that the increase of supplies meant that they had to *lower* enrollment in some courses due to lack of space to store them. Campuses experiencing this issue would not be able to depend on increased enrollment to sustain supply needs in the future. Grant management worked with these campuses during the final year to increase their capacity. Some were expanding classroom space, while others were adding new supplies or reconfiguring existing supplies to solve the issue.

Impact of Supplies and Network Control on Faculty Hands-On Instruction

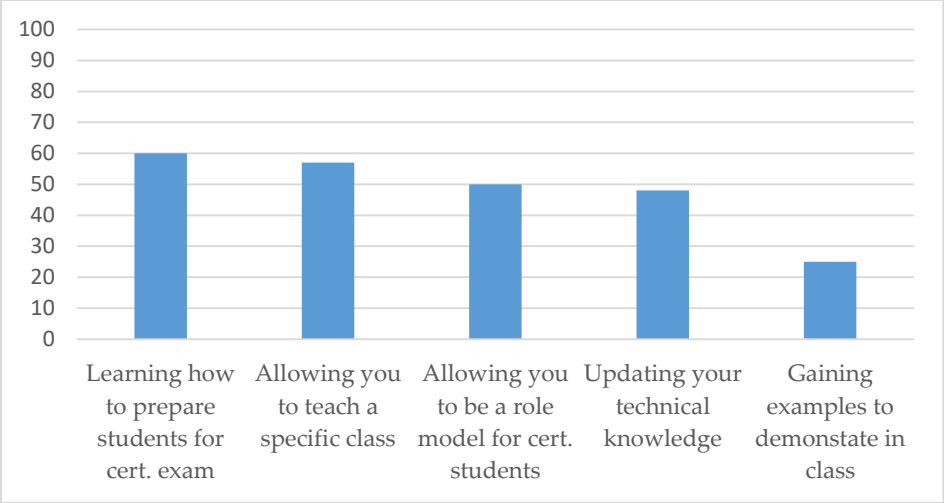
To assess the impact of equipment and supplies on faculty and on classroom experiences, we examine data from site visits at selected Ivy Tech campuses and surveys of CPIN and, later, School of Information Technology faculty and students. While equipment and supplies were broadly available to TAACCCT programs, we determined that three courses –

NETI 100 (Network Communications), NETI 105 (Network Infrastructure), and ITSP 135 (IT Support) – were the ones most likely to be directly impacted by the allocation of supplies and equipment; these became designated Hands-On Learning (HOL) courses. Our student survey therefore focused hands-on learning questions on students who took any of these courses. The survey was fielded each year beginning the second year of the grant. On the first- and second-round surveys, faculty members reported an increased use of hands-on learning in these courses. An increase in hands-on learning was reported for the final year as well, indicating that a longitudinal shift toward hands-on learning had occurred over the grant period.

Training helped faculty members implement hands-on teaching in the classroom. In the Round 3 survey, faculty who had participated in certification or training programs indicated that they were becoming more familiar with equipment and supplies and were better able to use them to instruct students. When faculty feel comfortable incorporating the new equipment and supplies into their courses, their students experience more hands-on learning throughout their college experience, which better prepares them for their future careers. Immediately after installation, many instructors did not feel confident using or running the new equipment. After receiving industry certifications, however, many became faculty champions – instructors who took a leadership role around a certification area – and were certified to train others (faculty champions are discussed in more detail later in the report). Additionally, faculty members indicated that obtaining industry certifications through the grant made them better prepared to teach their IT courses and said they felt better equipped to prepare students to take their own certification exams.

Of the faculty who responded to the Round 3 faculty survey (N=46), just under half (44%) indicated they had participated in industry certification training during the grant period. Of these faculty, the majority found the training extremely useful for helping them show students how to prepare for their industry certification tests (60%), teach a specific course (57%), be a better role model to students pursuing industry certification (50%), and update their technical knowledge (48%).

Figure 2. Percent of faculty respondents who completed a certification training who found it extremely useful.



Source: Round 3 School of Information Technology Faculty Survey (N=46)

As in past years, faculty members focused on the fact that you simply can't "tell" students how to do some elements of IT; you must show them, and better yet, let them do it themselves. One instructor during a fourth-year site visit said that the building of the data center itself became a learning opportunity for students, stating that "we actually built the equipment here, and a data center. . . . It was a great hands-on experience for them. We paid them part-time; it was a great learning experience for them. We needed someone to build that." This experience emphasizes the fact that even the act of implementing the TAACCCT grant created practical hands-on opportunities for students.

Faculty members reported that hands-on learning experience is more desirable than experience gained using an emulator or simulator. Interviewees emphasized the importance of actual hands-on learning as opposed to learning from an *emulator* (a virtual environment, such as a computer program, that replicates an activity as it would be performed on a real-world machine or program) or from a *simulator* (a constructed environment that models or mimics an activity and/or the environment in which the activity takes place). Many commented that equipment and supplies purchased through the grant enabled students to get a more realistic education and thus made them more employable. One instructor stated:

> With the equipment, they learn more with lecture and lab time. And what the real world is like with the hands-on. We also look at issues with the equipment. They learn that way. They hook up everything. The emulator does not do that. I ask them what they would rather have, a doctor who uses an emulator or one who does actual surgeries?

Another interviewee said students preferred the equipment to an emulator, saying that one student told him, "the emulator is fine, but there's nothing like the equipment. You can do stuff like recover passwords." He added, "for some of the routing protocols, it

won't show commands on emulators, but you can see the real thing on the equipment." Having the real-world equipment also allows instructors to present physical demonstrations to provide students with more precise instruction on what to do in a scenario and allows students to "learn on their own" when working independently.

Incorporating NetLab enhanced students' experiences with hands-on learning in the classroom – with some drawbacks. Most faculty members indicated that the use of NetLab, a remote circuitry laboratory accessed through the internet, was better than other options in terms of helping students acquire important skills when circuitry equipment was not available. One instructor stated, "It is nice to know they are using actual equipment, just doing so remotely, vs. [working with] a semi-functional emulator." And another emphasized NetLab's capability to grant more students access to the programs they need to succeed in their coursework: "It allows students who may not be able to load software on their machine to still use the needed software for the assignment." Instructors noted that, by enabling students to work with multiple software platforms without having to purchase them directly, NetLab helps them gain more experience they can use in the field. However, instructors did report that "real equipment is better 100 percent of the time," and that it can be time consuming for instructors and students to become familiar enough with the program for it to be a successful teaching tool.

Students' feelings about the NetLab experience were mixed. Students reported that the most helpful aspect of training on NetLab was working with the actual materials that they will be using in their future jobs and internships. While students appreciated having access to NetLab and reportedly made extensive use of the lab outside of class time, they were often frustrated by the time constraints placed on the lab experiences. Many students indicated that an hour was not enough time to complete the required tasks, and as a result, the learning experience was diminished. This was especially frustrating when grades were linked to task completion.

TAACCCT expanded the capabilities of Ivy Tech's School of Information Technology. At most campuses, TAACCCT allowed faculty and staff to pursue broader visions for their students by adding programs and expanding students' employment opportunities. Campus staff were very positive about these investments. One faculty member said:

> We have big plans for here. And the data center is a big driver of that. Without the data center, we can't have any of it. We couldn't get into cybersecurity or anything. We have a data center and two network labs. The grant has dramatically magnified the opportunities here.

Each campus we visited during the final year of the grant reported an increased ability to offer expanded learning opportunities to students compared to what they were able to offer prior to the grant; these echoed similar responses from the campuses visited during the first and second year of the grant. Students were able to experience more realistic and thus more educational scenarios by working with equipment that is the same as or similar to that used in the field, which respondents believed had a positive impact on students' college experience and increased both their confidence and employability. One faculty member said, "When we take

them [students] out or have employers come here, the students can see that it's [the equipment is] very similar to what exists out there in the work world. It's so much better than a simulator."

Other faculty noted that often the equipment and supplies replaced barely functioning or outdated equipment that was in desperate need of replacement. Previously, classes had been run using a combination of textbooks, videos, and old, donated equipment in lieu of equipment they lacked. One faculty member said,

> We had routers and switches that were donated to us that were ten years old, from other campuses or companies. Other campuses would get new equipment, and they would give us their old stuff. Or companies would upgrade and donate their old stuff to us. The servers worked, but they stopped working; we had them for ten years. We had no racks for them, so we rolled the things out with carts. Which is not very lifelike. Now we have the racks, and students can patch in to a router and a switch, and before it was picture and videos. That has been the biggest impact.

Students were very positive about hands-on learning. As in previous years, students expressed that they enjoyed the "hands-on aspect" of their IT programs and appreciated having access to the new equipment and supplies. Students in the focus groups who had transferred to Ivy Tech from four-year schools stressed the difference in education offered by the two settings, stating that Ivy Tech's IT programs offer many more opportunities for students to engage in hands-on learning. One student relayed the importance of hands-on learning in choosing the best career fit:

> I was taking ITSP [IT Support courses] and realized in a networking class that this [networking] is a better field. So, I did both. ITSP is more following scripts: You tell people what to do. [With n]etworking, there's more flexibility. I saw this through this hands-on work.

In other words, hands-on learning in the classroom gives students a more realistic understanding of the day-to-day functioning of available careers and the tasks that comprise them. This allows them to choose the field that is best suited to their skills and personalities.

Questions remain about how to sustain the updated equipment and supplies. Like past interviewees, those at the fourth-year site visits raised concerns about the sustainability of equipment and supplies purchased through the grant – especially the more expensive equipment. Many campus officials point to increased enrollments as key to sustaining current equipment levels. However, this is not possible on all campuses. The difficulty in sustainability is compounded by the fact that technology is constantly evolving, making classroom equipment and supplies obsolete quickly. Prior to the grant, many colleges depended upon industry members donating old equipment to use in the classroom. It is clear, however, that this model is not ideal, as "old equipment" tends to mean outdated equipment that is no longer used on the job. Interviewees repeatedly expressed that the equipment purchased with the grant is significantly better for student learning than in the past specifically because it was up-to-date, enabling students to learn on the equipment they would be using in the field. The ever-

changing nature of technology means that sustainability is difficult but important for student success.

Industry Certification Training

In an effort to increase Ivy Tech's capacity to offer industry certifications, the college began designating a "faculty champion" for each of the 12 IT-industry vendors who work with the college. Faculty champions typically focus on one certification area. They seek to act as a leader in the subject by coordinating with the vendor, mentoring and sharing information with other faculty, and serving as a general resource for faculty. They are also relied upon to promote and facilitate industry certification training among other faculty at the college. Ivy Tech has continued to develop and expand the faculty champion role since its inception. In developing this role, the school sought to designate IT faculty champions in the following areas: Android, EC Council, C++ Institute, CISCO, CompTIA, Microsoft, Oracle, Palo Alto, Linux, Salesforce, RedHat, and VMWare.

Faculty champions were developed to play a role in the professional development of faculty called for under the TAACCCT grant. Initially, the grant lead conceived the idea of faculty champions to promote increased trainings amongst faculty and students, enhance teaching, and maintain current vendor relationships. Because of the advantages of the role, faculty embraced the opportunity to become champions. Additionally, they enjoyed the opportunity for more training and higher pay. The grant manager stated:

> My dream is to give other faculty opportunities. When we do the CCDC [National Collegiate Cyber Defense] competition – we did it last year – the backbone is to get students to know Palo Alto. We were third or fourth place in the state. It's important for me to get it from the TAACCCT grant into the curriculum. I'm going to the conference; if the government is pushing for it, they know there's a demand for it.

Faculty champions were typically chosen to promote trainings for the certification subject they taught. They were usually involved with curriculum development on the subject and led committee discussions. Once becoming champions, they generally took the lead to coordinate relationships with industry vendors, conduct certification trainings for other faculty, and develop their own expertise in their respective certification area. Faculty who were already in leadership positions were often well-suited for the champion role. One faculty member in the role described being a faculty champion and lead chair as "one and the same." Another faculty champion described the role as follows:

> For me, it means taking the lead for certifications and instructional things. But it's also about being encouraging and providing leadership. For example, I'm doing this boot camp. Being a champion is a faculty role expanded; you're helping other faculty with getting whatever they need – certifications or class material. I am involved beyond my classes; I mentor other faculty.

This same faculty member described how he became involved in the role and how it evolved from his existing leadership role with teaching:

> Originally, I developed the *[certification area]* course. We decided, and I attended a curriculum meeting, to go ahead and lead the certifications since I was familiar with the course. Just to see how the cert and course aligned. I went ahead and took the cert to become an *[certification area]* and passed it, and it built from there. I developed the course, and I took the lead for the cert. I got more and more involved. In April, I'll be providing Android boot camp for our faculty to help them get certified. I want to help them get more knowledge to take the certifications.

Faculty champions also bolster industry engagement through their roles. In some cases, the faculty champion role helped to create new relationships within the industry. For example, some faculty engaged with industry vendors, such as Red Hat, for the first time. In such cases, they were able to launch new courses with the academies for the students.

Professional development opportunities through the grant were designed to create better-trained faculty and to increase capacity in the programs around the state. The new statewide effort to train faculty allowed the School of Information Technology to offer a wider range of IT classes at more campuses and to increase program capacity in general. According to one industry vendor representative, their company developed a partnership and worked together with the college to help update the content and tools used in the curriculum. The colleges also sought to increase awareness of the certifications needed for faculty and to help faculty members develop a plan for becoming certified themselves. One partner from an industry vendor described this need:

> They were using [industry vendor] in early 2015.We formed a direct relationship in late 2015, with the goal of wrapping up certifications, loose [industry vendor] content – we set up some updated content and tools – but also educating faculty and certifying them. We need qualified faculty. In late 2015, let's put a plan in place, get them certified, and have them teach courses. They partnered with us, they have to be certified themselves.

Some faculty became able to develop and teach new courses that had not been offered at the college before, thus broadening the options for Ivy Tech students. They also improved the content of existing classes by utilizing the materials from the industry vendors. One faculty member described plans for an upcoming class and the role of the industry vendor played in making those plans possible:

> I want to add more information for my students. I want to give them different materials so they can try different things. Like what outputs they can have – every day I'm changing their assignments. Through [from industry vendor], we have all the material.

Further, the added capacity allowed the faculty to take on more teaching opportunities in addition to their regular roles. This included some training with high schools that led to increased enrollments at the college. This also benefits faculty since they can earn extra income from the additional teaching.

Through this work on professional development, the TAACCCT grant manager was able to cultivate relationships with industry vendors who could bring new resources to the college. Some vendors provided direct donations to the college, including the following: Cisco Netacad (ebook, lecture, labs, quizzes, test); Red Hat (lecture, labs, ebook money, test prep); Oracle (JB, Java); EC Council (ebook money, lab money); and Linux (NDG Online). In some cases, the vendors have provided support to the college to help instructors better utilize their curriculum. For example, one industry vendor described the process of working with the college:

> We walk them through the job mapping with the resources. We started with a nice framework – what job roles are covered, what matters to the student, and ultimately the objectives with job roles – and then the syllabus, and then the lab exercises. Then we give them access to the resources, and we have them certified.

With a couple of the industry vendors, the college already had resources but became more aware of the resources available and learned better ways to use them. One faculty champion stated:

> There's a lot of material we wouldn't have been aware of. As far as teaching materials we didn't have access to, we have books, training materials, and more, that not everybody can get to. Our awareness was increased, and it's easier for our students now, too. They are better prepared for the certs.

While close relationships with industry vendors had benefits, some college staff pointed out the concern that the vendors were serving themselves by aiming to create new users through these certifications. As one stated: "Their bottom line is to move people to their new software. The academies are self-serving." However, the benefit of the certifications is that the industry vendors can convey skill needs and standards that may help students and their employability.

Faculty reported that certifications are important for students, and they encouraged students to pursue them. While they recognized the variability in the value of these certifications, many faculty reported that they thought certifications may help students in their careers. In particular, the combination of industry certification with the college certificate may have particular value. One faculty member mentioned that the industry certification in particular may be helpful for students who seek to complete programs quickly – e.g., in six months or less. As a result of these experiences and relationships, the college faculty and staff continue to think over the certifications and their value, especially within a national context. A faculty member commented:

> There's a lot of conversation going on in the state between Departments of Workforce Development and the Commission for Higher Education in regard to short-term training certifications. The Commission and the State has bought into Lumina's big goal, you've heard

> that, and there's realization now that a short-term certificate will count as a higher ed credential. . . . We're actually having a lot of discussions right now with the Commission of Higher Education.

The faculty champion role turned out to have many clear advantages and will likely be sustained after the grant period has ended. Faculty champions may be able to continue in their work coordinating relationships with industry vendors. By integrating this role into existing college staff, the TAACCCT project manager established an infrastructure within the college that would have the possibility of being sustained beyond the grant period. However, how this happens may vary across faculty champions depending on how the role fits into their existing responsibilities as faculty members. It is not clear if there will be additional guidance or support from the central office to ensure this structure persists after the grant period.

Advising

This section is meant to update advising implementation activities since the interim report.[4] A primary goal of the TAACCCT grant was to design and implement an advising tool to help advisors and faculty counsel students on their best education and career paths. In addition, grant staff wished to better understand students' advising needs and perceptions. During the first three years of the grant, an advising tool was planned, and the first three of four phases were rolled out: a planning phase, a mapping phase which resulted in a course map of available programs at Ivy Tech's School of Information Technology, and a digital video designed to inform students about the eight IT programs. Throughout the grant period, a series of surveys were also distributed in which faculty and student perceptions about student advising needs were explored. Planned prior to the TAACCCT grant but executed during the grant period, a pilot program meant to change the advising model at Ivy Tech was also implemented. In the sections that follow, we discuss the expansion of the pilot advising model across the campuses and the continued implementation of the advising tool.

Changes to Advising

As discussed in previous reports, Ivy Tech was going through expansive campus-wide changes to its advising model before and during the grant period. One of those reforms stipulated that Ivy Tech students are expected to see general, rather than faculty, advisors until they earn between 15 and 24 credit hours, depending on the campus. Because the multiple IT course pathways were sufficiently complex to require more intensive advising, however, IT faculty members at most campuses were advising students from registration through graduation, and many had a high caseload of students. Several faculty members we surveyed felt that without their help, students were likely to end up in the wrong program, an error that would require enrolling in extra courses and extending the time it would take to graduate. Students seemed to agree with the need for more guidance: Many reported needing more information, even after having seen a general advisor, about concerns such as the differences

[4] See Edwards, Douglas, Van Noy, and Vinton (2017)

between IT programs, how to meet math requirements, or which courses to take together. This arrangement resulted in IT students essentially having two or more advisors – a faculty advisor and one or more general advisors – which raised concerns among staff at central Ivy Tech that students were feeling "handed off" at several stages of their educational career. Moreover, even after speaking to multiple advisors, many were still not receiving all the information they needed.

Ivy Tech's advising model is being expanded school-wide. Central Ivy Tech developed a "faculty-mentorship" model of advising that was piloted at three campuses (Terre Haute, Valparaiso, and Sellersburg). Planning began in Spring 2017, and the pilot was launched the following Fall term. Scaling of the model to all Ivy Tech campuses was scheduled to begin at the time of this writing, in Fall 2018. The model combines general and faculty advising to give students one general advisor and one faculty "mentor" that will remain constant from orientation through graduation. The two advisors are expected to communicate regularly and keep shared notes on each student. The model eliminates the need for students to jump from advisor to advisor while pursuing their degree. One advisor said,

> Some folks still in the pipeline are disillusioned. Four or five years to get an associate degree, and during that time they may have seven or eight advisors, faculty, etc. At a point they would lose track of who to talk to when there have been so many people involved. Then they go right back to self-advising.

Another advisor noted, "There wasn't that sense of center for students to understand what the heck is going on, and there wasn't that sense of center for information." The pilot model theoretically gives students more stability – a "base that is with them all the way through" their education. Students will have "their faculty member to talk to about curriculum content and career, and earnings, etc., [and] their advisor to talk to about financial aid and grade appeals, etc." This division of labor was already helping both faculty and advising staff at pilot campuses. One advisor said, "The division of labor helps. The faculty don't rebel as much when they don't feel like they have too much to do. And advisors don't feel like they have to be a deep-dive expert in terms of programs."

Faculty and staff were positive about the advising-model changes. Although it was not a huge change, interviewees at all three campuses were positive about the new advising model, and by the end of the grant, all three campuses had elements of the new model already in place. The biggest change reported was the length of time students had both general and faculty advising available to them: For IT students, that period stretched throughout the entirety of their time at Ivy Tech instead of being restricted to their last two semesters. In addition, a staff member at Sellersburg reported that the rollout of the new model on that campus allowed students to access other support services in one area:

Instead of advising for just 15 credit hours and then moving [students] to a faculty member within their area, we [general advisors] are advising all the way through their academic life, when they move on or transfer. [We have] doubled the advising staff since the

change. Disability services and career development has moved into our offices, now it's like a "one-stop shop" for academic advising for the students.

It was challenging to get students to talk to their faculty mentor. Several faculty members and advisors at the pilot schools noted that the biggest challenge was getting students to communicate with their faculty mentor, attend events, and ask questions. In most cases, they found that students tended to procrastinate about seeking out information and did not want to attend events regardless of their benefit. They also found that students were not seeking out their mentor to ask questions about their career or education pathway. One advisor said, "we can't force students to meet." At two schools, Sellersburg and Terre Haute, students were asked about why they were not seeking out their faculty mentors. Many replied that they could just ask their instructor in class and did not need to go to a career fair or employer event or seek the instructor mentor out to get information. This may reflect the size of the campuses – since these campuses were relatively small, students had several courses with their faculty mentor and thus apparently did not see the benefit in contacting them outside of classes.

Likewise, some faculty feel they lack the same relationship they had with students prior to the mentorship model. One advisor said,

> We have had some general faculty complain that they have less of connection with students now. But it's on the faculty to do some outreach. Previously students would have gone to faculty, but now they are coming to general advisors.

Because general advisors met with faculty at least once per month during the grant period, advisors felt they had more information about the programs and that students did not need to contact faculty as frequently as they had before.

Student survey respondents indicated they saw an advisor at least once. Almost three quarters of the respondents to our Fall 2017 student survey indicated that they had seen an advisor either once or more than once (73%). However, 43 percent of student respondents indicated they still needed more information about the differences among the eight IT programs after seeing a general advisor. This proportion is about the same as last year and indicates that although considerable effort has gone into reforming the advising model and creating and providing advising tools, students are still leaving general advising with questions about the IT programs. Since the new advising model is still in the early phases of implementation and the final phase of the advising tool is not yet complete, there is hope more students will leave their advisory experiences with all their questions answered in the future.

A common core of courses is being created that will simplify the process of choosing among them. Another change expected to be implemented in Fall 2018 is the creation of a common core of courses that all IT students will take during their first semester. This change should help eliminate some confusion and keep students from getting "off track" during their first year. Because all students will take the same courses upon entering the program, this will also take some pressure off advisors, who will no longer need to help students choose the

correct program immediately. Most campuses had already been guiding students to take a common core, but the program-wide change in Fall 2018 will make it "official" and create formal processes to ensure all students enroll in the same required courses. It is hoped that by the end of their first year, students will have a clear understanding of the eight programs and will be better able to choose the one that for which they are best suited.

It is also hoped that offering a faculty mentor throughout the entire year will help decrease instances of self-advising. Over one quarter of students surveyed (27%) had never been to an advisor, indicating that despite the reforms made to the advising model, about the same number of students reported self-advising in 2017 as had reported doing so in 2016 (25%). One advisor said the proportion of students self-advising on his campus is probably even higher than that: "Each advisor has 300 students assigned to them in a given load, and we usually see one half to two thirds of that." Although finding a time to meet with an advisor may be challenging, he noted that self-advising was not an adequate replacement for the services they provide:

> [Planning course schedules with an advisor is] mostly about staying on sequence and taking courses when available; that's the trick. We're a small campus, so it's more about taking the courses they need to take when they are available. Some classes are ONLY available in the spring, some ONLY in the fall. So if you don't know that and you're self-advising, then you're going to find out the hard way, and it will take longer to finish. You'll get off track.

Student interviewees on several campuses said that one of the reasons they don't see an advisor is because they already work in the industry and have the information they need. Several noted they probably "know more about [the career] than the advisors." For course information and scheduling, they rely on the website. However, many students seemed more interested in talking to faculty members than advisors, indicating that the faculty-mentorship model of advising may help curb student self-advising.

Faculty Involvement in Advising

As in 2016, respondents to the 2017 faculty survey indicated they are regularly involved in advising students about education and career path decisions. About two thirds (67%) indicated they are involved in student advising. Most faculty indicated they spend less than one quarter of their time advising students. This is to be expected given that faculty also have a full load of teaching responsibilities. Last year's survey reported faculty spent about the same amount of time advising.

IT students still had advising needs after seeing a general advisor. Students' most common questions had to do with the differences between the eight programs, the best order to take program courses, and the best courses to take together; over 70 percent of faculty members reported that they respond to questions about these topics either often or very often. Other topics faculty respondents reported addressing frequently had to do with the specific jobs or careers that are associated with each program and the skills required in different jobs/careers

with about over half reporting these topics often to very often. Given the data above – that students leave general advising without all the information they need – it is not surprising to discover that they later ask faculty advisors for the information.

Ivy Tech's new model of advising requires a somewhat higher level of faculty involvement, as faculty will be mentoring students throughout the entire course of their education at the School of Information Technology. The number of students they will see at any given time should decrease, however, since students will have access to faculty any time during the school year. Although it is too early to see results in the data, it is also assumed that students will be getting their informational needs met earlier in the process than they had previously.

Advising Tools Implementation

Three phases of the advising tools development have been completed and implemented to date. Creation and implementation of these phases, including the creation of complete program maps and a video about the programs, were discussed in the interim report. In this section, we discuss the tools' usage and evaluate faculty and student perceptions of its usefulness based on data from interviews and surveys. We also discuss the status of the fourth and final phase of development– the creation of the career guidance tool.

A majority of faculty reported not using the program maps or video regularly. During the final year of the grant, the program maps and School of Information Technology video was available to all advisors and faculty members on all campuses. The career maps and video were completed and distributed to advisors and faculty during the second year of the grant (both were complete by November 2016). In the third year of the grant (discussed in the interim report), interview and survey results from students, faculty, and advisors indicated that while some faculty and advisors had seen or were using the maps and video to advise students, a majority were not using them regularly. A big change during the final grant year was the decision to make the advising tool resources open to the public. This was expected to increase use of the resources because it will be the first time students have direct access to these resources; previously, the resources had to be shown to them by a faculty member or advisor. The program maps, program video, and career guidance tool will all be housed on Ivy Tech's public-facing website.

Program maps. Faculty respondents from the final round of interviews and surveys indicated that a higher proportion of faculty had seen or were aware of the IT program maps than had encountered them in previous years. About half (52%) indicated they had seen the maps, compared with only 43 percent of respondents to the 2016 faculty survey.[5] Interviews supported this result, as more interviewees seemed to have heard of the maps than had reported knowledge of them in prior years. Some interviewees only knew of the maps through

[5] For the interim report, 87 faculty responded to the survey. For this survey, 46 faculty responded. Faculty responses, therefore, should not be considered representative of the total Ivy Tech faculty population.

description, however, indicating that some faculty and general advisors may use the maps but are not aware of what they are called. That could indicate that faculty and advisors are underreporting usage of the maps in surveys. One faculty member said, "[The map] shows the majors, classes . . . We use it for advising. This is my go-to for advising." However, many faculty members, especially those on smaller campuses or in smaller departments, indicated they did not rely on the maps because they felt they already knew the information.

Of the faculty survey respondents who indicated they had seen the program maps (N=24), about 39 percent reported they had used them in advising students. Since general advisors, not faculty advisors, were the intended audience for the program maps, these findings are not that surprising. Of those who had seen the program maps, 38 percent found them very useful, and nearly as many found them somewhat useful. Fewer –24 percent – found them not very useful.

Since the number of respondents to the faculty survey is low, this analysis should be used for contextual purposes only. However, given that interviews and the prior two years of survey data reveal similar results, the information does indicate a trend. More faculty members are aware of and have seen the program maps, but most do not use them. Of those who do, most find them useful. Overall, faculty seem more likely to rely on their own knowledge and the knowledge of their colleagues than on the program map when they need information.

During the final year of the grant, the program maps were undergoing revision because changes had been made to the curriculum. In addition, two new documents were being created that showed the critical pathways of each program. These would list prerequisites for each course and indicate what industry certifications were available through each program. These documents and the revised course maps are further evidence of Ivy Tech's commitment to making sure the eight IT career pathways are clearly and accurately represented.

Advising Video. Although the School of Information Technology advising video was distributed during the second year of the grant, many faculty members still had not seen it as of the final year. The intended audience for the video, however, was general advisors; it was meant to offer them information about each of the eight program areas so that they could better help students choose the right career path. Under the revised advising model, by the time students see a faculty advisor, they have chosen a program path and have completed a significant portion of it. Still, grant management disseminated the video widely to faculty and advisors alike and encouraged all staff to show it to students.

Few faculty members indicated they had seen the video. Only about one quarter of 2017 faculty survey respondents (24 percent) reported they had been it, though most of those who had seen it had used the video as an advising tool with students (66 percent). Most student respondents (88%, N=707) also indicated they had not seen the video. Of those who had seen it, nearly all (94 percent found it at least somewhat useful, however. The number of students aware of the video will likely increase now that it is publicly available on the Ivy Tech website.

Career Guidance Tool. The final phase of the advising tool is a career guidance tool that either will be administered to students by advisors or will be self-administered by students who access it through a campus website. The goal of the resource is to help students decide which of the eight programs would be a good fit for them. The tool will ask students a series of questions and then give them guidance about which program(s) and career(s) may be best suited to them based on the students' answers. The resource bases its results on student confidence and interest levels relative to several IT-centered categories.

This phase of the rollout was significantly delayed due to a lack of staff with the skills necessary to create the resource. The grant manager used Ivy Tech student interns to develop pieces of the tool and partnered with Ucertify – a company that offers IT exam preparation for a variety of professional certification tests – to create appropriate questions relative to labs and certifications. The guidance resource had gone through several iterations and was functional by the time data collection for this report ceased in the summer of 2018, but rollout was on hold while the resource development team waited for faculty feedback on the questions. Grant management hoped the review process would be completed by the end of the summer so that the tool could be used during advising for the 2018–2019 academic year. They also hoped that making the resource publicly available to students on the college website would ensure its use.

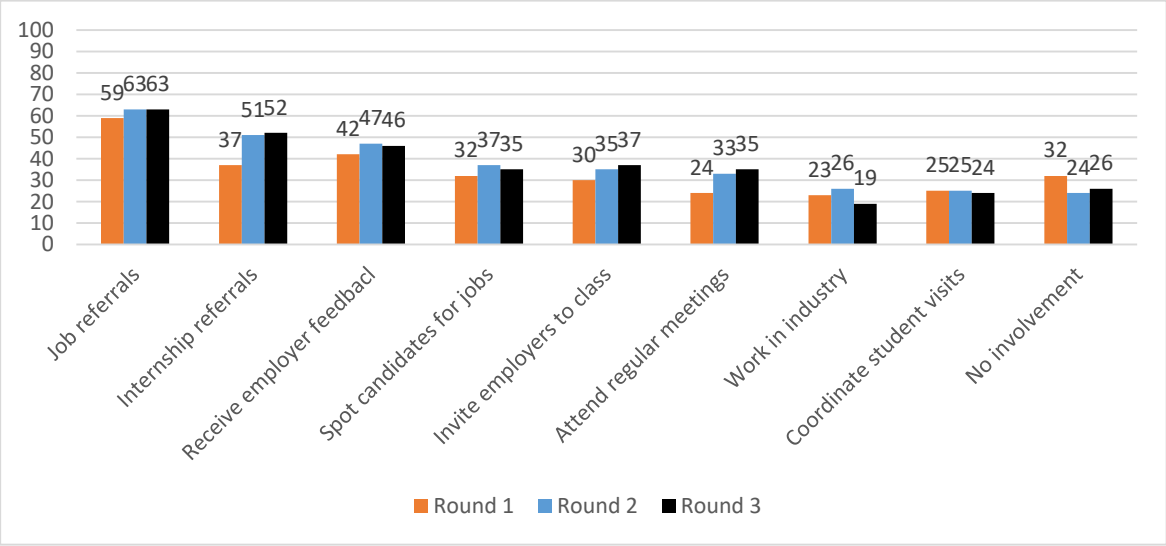
Employer Engagement

To better prepare students for employment, the grant sought to expand employer engagement with the new School of Information Technology programs. The primary means for accomplishing this goal was the development of advisory boards designed to promote employer involvement in curriculum reviews, the provision of internships and capstone projects, and job placement. In addition to developing relationships with specific employers, the grant also sought to promote engagement with the workforce system as a whole. During the first year of the grant, all campuses either created or revamped existing advisory boards, worked with employers to identify which supplies to purchase for programs, and began building relationships that would help them place students in employment upon graduation. At the end of the first year, employer engagement was increasing, but it was not to the level grant administration had envisioned. During the second year of the grant, employer engagement continued to grow, and it remained steady during the third year.

By year 3 of the grant, employer engagement was a central part of grant activities. Faculty reported focusing predominantly on involving employers by 1) engaging in job referrals for students, 2) engaging in internship referrals for students, and 3) receiving feedback from employers relative to coursework. An additional goal of employer engagement was the improvement of labor market alignment. This was accomplished through the use of advisory boards, internships, job placement, and other activities such as project-based learning, class visits by employers, and worksite visits for students and faculty.

Faculty member's reports of employer outreach remained steady over the past year. Based on site-visit interviews and a survey fielded that year, little had changed since the Round 2 survey in terms of activities related to industry involvement or activities that brought together students and employers. Campuses continued to focus on local advisory boards, while grant management maintained a statewide advisory board. Overall, the Round 3 faculty survey revealed few changes relative to employer engagement. Year-by-year comparisons are shown in Figure 3. Nearly two-thirds of faculty (63%) responding to the Round 3 (2017) survey reported engaging in job referrals for students, about half (52%) reported engaging in internship referrals for students, and 46 percent reported receiving feedback from employers for their courses. These numbers are almost identical to those reported the previous year (63%, 51%, and 47%, respectively), yet remain an increase over those reported on the Round 1 faculty survey (59%, 37%, and 42%, respectively), particularly with regard to faculty engagement in job referrals. The largest change reported in 2018 was a 7 percent decrease among faculty who work in the industry – 19 percent of faculty reported having a job in the industry on the Round 3 survey compared to 26 percent in Round 2.

Figure 3: Percent of faculty reporting involvement with employers/industry.



Sources: Round 1 CPIN Faculty Surveys (N=83); Round 2 CPIN Faculty Survey (N=87); Round 3 School of Information Technology Faculty Survey (N=46)

These numbers reveal that overall, employer involvement from faculty is increasing at Ivy Tech. Most telling is the number of faculty members *not* involved in employer engagement; this number decreased by almost 8 percentage points between the Round 1 and Round 2 surveys – from 32 percent to only 24 percent.

We also asked faculty about how they involved faculty in their course planning and whether and how they linked employers with students. The survey presented them with several forms of employer involvement, and they were asked to rate how useful they felt such involvement was to their students. Table 1 shows the proportion of faculty that found each

survey item in this section either extremely useful or very useful. All faculty members surveyed (100%, N=46) felt that internships for students were either extremely or very useful. Although fewer faculty reported actually referring students for internships that year (only about 52% made referrals), support for those placements indicates that faculty recognize the benefit of the activity. This pairing of high levels of support with lower levels of real-world behavior turned out to be a common pattern in the Round 3 data. While 93 percent of respondents believed that seeking employer input about the skills the look for in potential employees was a useful activity, only 46 percent indicated they had done so. Likewise, the majority of faculty respondents (88%) indicated that featuring employers as guest speakers in classes was a useful activity, but only 37 percent indicated they had done so. Thus, while the Round 3 data saw an increase over the previous year in the number of faculty who recognized the usefulness of employer engagement, this increased recognition was not accompanied by an increase in employer engagement activities.

Faculty suggested ways in which they would benefit from institutional support. The lack of increase in employer engagement activities may be due to limits on faculty respondents' time, which many reported as a barrier. When asked, 46 percent stated that they would benefit from either more time or from the addition of a staff member hired specifically to focus on employer engagement. Other suggestions included a larger budget for employer engagement and more information on local employers.

TABLE 1. PERCENT OF FACULTY REPORTING SPECIFIC EMPLOYER ENGAGEMENT ACTIVITIES ARE VERY OR EXTREMELY USEFUL, 2017

Type of Involvement	Percent Reporting Very or Extremely Useful
Internships for Students	100
Share Information on Job Opportunities with Students	98
Job Shadowing/Visits to Job Sites for Students	95
Employer Input About Skills Sought in Potential Employees	93
Employees as Guest Speakers in Classes	88
Other	2

Source: Round 3 School of Information Technology Faculty Survey (N=46)

IT Competitions

In Spring 2018, the college hosted its second statewide IT competition, the IT Spring Expo. The event featured eight competitive events; each of the events was two hours long and focused on one of the eight program areas offered by the School of Information Technology. The competition was conceived primarily to serve as an opportunity for Ivy Tech students to compete and work alongside peers from across the state and to test the skills they had learned

in the classroom to solve a challenge specific to the field of IT they had studied. Faculty and staff from the School of Information Technology served as judges, and the first competition, held in 2017, was held on a single day in a central location so that students from all Ivy Tech schools could participate. The Indianapolis campus hosted the 2018 event, which expanded on the 2017 model to include an IT Career Fair and Cisco Academy Conference. As in the first competition, all 19 Ivy Tech campuses were invited to participate, and the competition was split into several IT domains, such as server administration and cyber security. Some changes were made to the basic structure of the event, however, as planners of the second competition sought to improve the event and address some of the challenges that arose the first year. Challenges included some technical glitches as well as concerns over time management related to the constraints of fitting the event into just one day. In response, the 2018 Expo was planned to span two days, as faculty and staff sought to make the event more multifaceted for students by adding the career fair conference. Ultimately, 166 students took part in the 2018 competition –an increase over the first year – 300 students took part in the job fair, and 70 faculty participated as advisors and judges.

The college ran the competition on a relatively low budget that included in-kind contributions and donations from vendors. The event's cost was ultimately scaled to $10,000 – a stark contrast to the cost for a typical expo, which could cost up to about $120,000, according to the college's consultant. The college offered its public services building to host the event. When planning for the competition, the college's project manager sought to promote scholarship awards and worked with the Ivy Tech's foundation to encourage them to increase the awards. A noted accomplishment was that the college obtained permission to grant $3,000 scholarships to all 19 students who won gold awards in the competition's second year. Additionally, the college received significant support from industry vendors for the competition ranging from their participation in the event to financial and material support. Vendors also showed support toward faculty in various ways, such as by providing them with discount vouchers and certification awards. Vendors such as Red Hat donated checks that served as scholarships for students that could be redeemed for any courses of their choosing.

To plan for the competition, the college underwent a collaborative process that involved faculty from around the state to ensure that each challenge integrated and aligned with its corresponding curriculum. The college worked with a consultant throughout this process to help organize and plan for the event. Planning for the competition took eight to nine months, and this time period allowed stakeholders to discuss and reach a consensus on how the competition should look for each event. Those involved in the event found that the planning, competition itself, and aftermath fostered stronger relationships between faculty, staff, students, and industry vendors. There was continual engagement between faculty and students, especially prior to and during the competition. As one faculty member noted about the benefit of the competition: "It's a great way to bring the state together; they're [competitions are] good for student development and résumé." Additionally, faculty and staff experienced more communication with the vendors involved, spurring the idea of future competitions serving as public relations opportunities.

Faculty reported students benefited from applying skills they'd learned in the classroom and seeing their performance relative to other students. Those who participated actively prepared with their instructors, meeting weekly at computer club meetings. As the consultant predicted, students performed in the competitions based on their academic performance. Students showed subdued appreciation for the learning experience and scholarship awards. Not only could students assess their own skill levels, they could also sharpen them and learn more about their industry of interest. One faculty member observed that the competition provided the following opportunities for students:

> [The competition] provided a chance for students to put their skills to use in a competitive environment, made students aware of industry interest in their areas, [and] also gave them an incentive to sharpen their skills in their areas. [It presented] "real life" pressure situations for students (and faculty) to see where each stands with respect to knowledge content mastery.

Faculty were particularly supportive of students' participation as a way to enhance their academic experience. The stronger a student's performance in school, the more likely they would perform well in the competition, as competition tasks complemented students' academic work. As a person involved in the planning of the competition observed:

> So a student would do better in these competitions if they're doing well in school. It was gratifying to watch; they were respectful of each other. That was really fun for me because there were no enemies, other than available time. They are very busy, and their class schedules are intense.

However, when recruiting students for the event, the college found that many students were not aware of it or were not able to participate because of time constraints. Ultimately, many students expressed interest, but their class schedules impeded their ability to prepare and participate in the event.

On sustainability, organizers plan to continue the competition next year, but will need to secure additional financial support to maintain or expand the event. Grant money will be necessary as it was before, and more buy-in and investment will also be critical from business partners. In some cases, approval may be needed for some grants, depending on who the sponsor is. Faculty and staff aimed to have more students participating in future events, given the benefits in terms of skill-building and industry exposure, and they expressed interest in expanding the competition to other fields, specifically those representing the various schools at Ivy Tech: healthcare, engineering, and public safety.

IV. STUDENT CHARACTERISTICS AND OUTCOMES

In this section, we present in four broad sets of analyses of Ivy Tech student administrative data. We first present a descriptive analysis of the students served over the course of the grant, their choices of programs, and their credential-completion outcomes. Next,

we explore the role instructional format plays in student success in a set of introductory-level IT courses. In the third part of this section, we assess the pathways of first-time IT students through their first two academic years. Our final analysis builds on the third by using quasi-experimental techniques to compare IT students' pathways outcomes with those of similar students in other Ivy Tech academic programs.

Part 1: Student Demographics and Summary Outcomes

Below we analyze Ivy Tech's student administrative data to assess the characteristics of students served by the TAACCCT program and examine the overall impacts of the grant. TAACCCT program participants are defined as Ivy Tech students over the age of 18 who either majored in an Information Technology (IT) field of study or took at least one course supported by TAACCCT funds. Table 1 reports the characteristics Ivy Tech's TAACCCT program participants. The student population is divided into the four grant years, and students are defined by the year in which they first participated in the program. As such, the first grant year had the most first-time program participants, since it includes all continuing students who were already enrolled in IT programs in addition to incoming students new to the program that year. The data for program year 4 are incomplete, as they only include Fall 2017 students; this explains the relatively small size of the TAACCCT population for that year.

TABLE 2. DEMOGRAPHICS OF TAACCCT PARTICIPANTS BY FIRST PROGRAM YEAR

	Year 1 2014–15 (N=9,669)		Year 2 2015–16 (N=4,036)		Year 3 2016–17 (N=3,935)		Year 4 Fall 2017 (N=1,449)		Grant Total (N=19,089)	
	#	%	#	%	#	%	#	%	#	%
Gender										
Male	7,387	76.4	2,989	74.1	2,916	74.1	1,059	73.1	14,351	75.2
Female	2,170	22.4	988	24.5	937	23.8	375	25.9	4,470	23.4
Not Reported	112	1.2	59	1.5	82	2.1	15	1.0	268	1.4
Ethnicity										
White	6.948	71.9	2,765	68.5	2,692	68.4	966	66.7	13,371	70.1
Black/African American	1,402	14.5	598	14.8	592	15.0	224	15.5	2,816	14.8
Hispanic/Latino	377	3.9	147	3.6	124	3.2	55	3.8	703	3.7
Asian	254	2.6	161	4.0	132	3.6	60	4.1	607	3.2
Native American	65	0.7	20	0.5	15	0.4	7	0.5	107	0.6
Unknown/Multi/Other	367	3.8	160	4.0	158	4.0	75	5.2	760	4.0
Not Reported	256	2.7	185	4.6	222	5.6	62	4.3	725	3.8
Other Characteristics										
Pell Recipient	5,729	59.3	2,169	53.8	2,081	52.9	667	46.0	10,646	55.8
Veteran	745	7.7	336	8.3	316	8.0	128	8.8	1,525	8.0
Incumbent Worker	5,455	50.8	2,930	59.3	2,858	60.9	--	--	11,243	55.2
Age in First TAACCCT Year, Mean (sd)	29.7 (10.4)		27.8 (10.3)		26.1 (9.8)		25.9 (10.2)		28.3 (10.4)	

Source: Ivy Tech administrative records data
-- Not measured for this cohort

The TAACCCT grant served students representative of IT programs and of Ivy Tech. A large majority – approximately three quarters – of all TAACCCT participants were men; this did not vary by program year and reflects the gender distribution of IT programs nationally. Reflecting the demographics of Ivy Tech, the majority of TAACCCT participants were white; the proportions of students identified as "Asian" or "Other/Multiple Races" grew somewhat over the course of the grant. Just over half (56%) of the students served by the grant were identified as recipients of Pell grants, and 7 percent were identified as veterans. A majority of students in each program year – 55 percent over the course of the grant – were incumbent workers, meaning they were employed during the term in which they first participated in the TAACCCT program. Students served by the program were over 26 years of age on average, though the average age of participants became lower each year: In year 1 of the grant, the mean age of students was 30, but by year 4, that average had dropped to age 26.

TAACCCT served students across the spectrum of IT programs. Table 3 describes TAACCCT program participants' chosen fields of study and graduation and transfer outcomes. Over the life of the grant, about one in five participants either did not pursue a program of study (Courses Only – 7%) or chose a non-IT field (19%). The first year of the grant involved a redesign and combination of Ivy Tech's IT programs, so it follows that this year had the highest proportion (29%) of TAACCCT participants enrolled in pre-TAACCCT IT programs. Among new program enrollees in year 1 and all enrollees in years 2 through 4, we observe that Computer Science (CSCI) and Software Development (SDEV) were generally the most popular IT programs offered by the School of Information Technology. IT support (ITSP) was the next most popular field of study among TAACCCT participants who declared an IT field of study.

TABLE 3. PROGRAM CHOICES AND OUTCOMES FOR TAACCCT PARTICIPANTS DECLARING AN IT FIELD OF STUDY, BY PROGRAM YEAR

	Year 1 (N=9,669)		Year 2 (N=4,036)		Year 3 (N=3,935)		Year 4 (N=1,449		Grant Total (N=19,089)	
Program of Study	#	%	#	%	#	%	#	%	#	%
Computer Science (CSCI)	1,373	14.2	700	17.3	743	18.9	241	16.6	3,057	16.0
Cybersecurity (CSIA)	412	4.3	275	6.8	381	9.7	139	9.6	1,207	6.3
Database Management (DBMS)	231	2.4	112	2.8	94	2.4	38	2.6	475	2.5
Informatics (INFM)	326	3.4	272	6.7	315	8.0	113	7.8	1,026	5.4
IT Support (ITSP)	898	9.3	451	11.2	380	9.7	148	10.2	1,877	9.8
Network Infrastructure (NETI)	253	2.6	138	3.4	159	4.0	56	3.9	606	3.2
Software Development (SDEV)	1,076	11.1	666	16.5	553	14.1	199	13.7	2,494	13.1
Server Administration (SVAD)	219	2.3	66	1.6	68	1.7	23	1.6	376	2.0
Old IT Programs	2,824	29.2	102	2.5	30	0.8	13	0.9	2,969	15.6
Non-IT Program	1,549	16.0	918	22.8	862	21.9	343	23.7	3,672	19.2
Courses Only	508	5.3	336	8.3	350	8.9	136	9.4	1,330	7.0
Transfer & Graduation										
Any transfer	1,759	18.2	577	14.3	306	7.8	33	2.3	2,675	14.0
Transfer to 4YC	1,662	17.2	540	13.4	282	7.2	31	2.1	2,515	13.2

Transfer in State	1,345	13.9	457	11.3	239	6.0	26	1.8	2,067	10.8
Ivy Tech Credential	2,442	25.3	479	11.9	252	6.4	61	4.2	3,234	16.9
Ivy Tech Credential or Any Transfer	3,612	37.4	959	23.8	528	13.4	92	6.4	5,191	27.2

Source: Ivy Tech administrative records data

The data indicate strong evidence of credential completion and transfer. Examining graduation and transfer outcomes, we observe that 5,191 (27%) of TAACCCT participants either earned a credential or transferred to another institution. Since the overwhelming majority of transfer students transferred to institutions that grant 4-year degrees, either outcome should be considered a success. Because students from earlier program years have had more time in which to complete their degrees, the lower proportion of students from later years graduating or transferring should not be read as an indication of poorer student performance or diminished program outcomes.

TAACCCT students earned associate degrees, certificates and short-term certifications. Table 4 displays the type of credentials earned by TAACCCT participants. As noted above, 3,234 students earned a credential during the grant period, but because many Ivy Tech students earn multiple credentials, the total number of credentials earned is much higher: 5,936. Associate degrees were the most frequently earned credential (36%), followed by technical certificates (33%). The majority (79%) of credentials were earned by members of the first TAACCCT cohort, which is unsurprising for two reasons: first, because that cohort was the largest, and second, because those students were enrolled longest over the course of the grant. One expects that later cohorts will have similar patterns of credential earning in the future.

TABLE 4. CREDENTIALS EARNED BY TAACCCT STUDENTS, BY TYPE AND STUDENT PROGRAM YEAR

	Associate Degrees	Certificates	Technical Certificates	Certifications	Total
Year 1: 2014-15	1,804	759	1,424	686	4,665 (78.6%)
Year 2: 2015-16	203	146	291	141	781 (13.2%)
Year 3: 2016-17	116	59	160	64	399 (6.7%)
Year 4: Fall 2017	27	9	54	1	91 (1.5%)
Total	2,150 (36.2%)	965 (16.3%)	1,929 (32.5%)	892 (15.0%)	5,936

Source: Ivy Tech administrative records data

TAACCCT students earned credentials throughout the grant period. Table 5 breaks down the number of credentials earned by TAACCCT participants by semester awarded. We observe that most credentials earned each year are earned in Spring terms. More importantly, we note that credentials were earned by students regularly throughout the grant period. This indicates that students in later TAACCCT cohorts can be expected to earn credentials at the same rate as their peers in the earlier cohorts.

TABLE 5. CREDENTIALS EARNED BY TAACCCT STUDENTS, BY TYPE AND TERM AWARDED

Term	Associate Degrees	Certificates	Technical Certificates	Certifications	Total
Fall 2014	220	71	154	202	647 (10.7%)
Spring 2015	334	79	223	274	910 (15.1%)
Summer 2015	108	38	69	98	314 (5.2%)
Fall 2015	199	66	163	13	441 (7.3%)
Spring 2016	337	129	232	15	713 (11.9%)
Summer 2016	125	39	101	0	265 (4.4%)
Fall 2016	199	113	336	27	675 (11.5%)
Spring 2017	311	134	242	130	817 (14.0%)
Summer 2017	99	131	136	19	385 (6.6%)
Fall 2017	218	165	273	110	766 (13.3%)
Spring 2018*	0	0	0	4	4 (0.1%)
Total	2,150 (36.2%)	965 (16.3%)	1,929 (32.5%)	892 (15.0%)	5,936

*Quarterly data incomplete on date of data collection
Source: Ivy Tech administrative records data

Stacking multiple credentials was common. Table 6 visualizes the phenomenon of credential stacking among TAACCCT program participants by displaying what proportion of students earning each type of credential also earned additional credentials during the grant period. About half of TAACCCT students who earned any credential earned more than one, with 20 percent earning three or more. Most students who earned associate degrees earned one additional credential (59%), though many appear to have also earned certificates – this is the most common pattern of credential stacking. Over three-quarters of credential earners (77 percent) have at least one certificate. As we noted in our discussion of Table 2, many students served by the TAACCCT program did not enroll in IT fields of study, so many credential earners served by TAACCCT did not earn an IT credential.

TABLE 6. CREDENTIAL EARNING AND STACKING AMONG TAACCCT STUDENTS (N=3,300)

	TAACCCT field of study credentials	Associate Degrees	Certificates	All Credentials, any type or level
None	37.4%	37.0%	22.9%	0%
One	30.7%	59.8%	51.4%	49.9%
Two	16.7%	2.8%	16.1%	30.1%
Three	8.7%	0.3%	6.4%	11.7%
More than three	6.5%	0.03%	3.2%	8.3%

Source: Ivy Tech administrative records data

Part 2: Instructional Format Analysis

In the interim report[6] we attempted to assess the impact of the increased hands-on-learning made possible by additional IT labs, equipment, and supplies purchased for and distributed to Ivy Tech campuses using TAACCCT grant funds. We based our conclusions on an analysis of course outcomes in a set of key introductory-level IT courses determined to be the most directly impacted by the new supplies. In designing the current analysis, we considered that many of Ivy Tech's IT courses are offered in either an online-only format or a hybrid format that combines traditional classroom instruction with significant online content students engage with outside of the classroom. Neither of these course formats easily lend themselves to hands-on instruction, though the hybrid format presents limited opportunities to students that online-only study cannot.

Irrespective of the impacts of the TAACCCT grant (we analyzed courses before and after the grant and found modest positive impacts), the analysis from our most recent report showed that online-only instruction was associated with poorer course outcomes, and minority students fared relatively poorly in introductory IT courses taken online.[7] We therefore decided to go further with the analysis of instructional format in this final report.

We ask the following questions in this analysis:

1. What is the state of online-only and hybrid course-taking in introductory-level Ivy Tech IT courses?
2. Who takes online-only courses?
3. What are the impacts of course format on student course outcomes?

Data indicate growth in IT Support courses and online-only instruction. We first examine course types and formats as they varied over time. We note here that courses in IT Support (ITSP 135) came to represent a larger proportion of courses taken over the span of three years. (See Table 7.) This is likely because ITSP 135 became a requirement for a number of IT programs. In terms of format, the change over time is more pronounced. For these introductory courses, online-only became the predominant instructional format, overtaking traditional classroom courses. This is relevant given our findings in earlier reports regarding the impact of online-only instruction on course outcomes, which are reinforced by the findings from our current study. We begin this section with a look at the introductory-level course offerings and the instructional formats in which those courses were offered. The data are broken down by academic year in Table 7.

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[6] Edwards, R., Douglas, D., Van Noy, M., & Vinton, J. (2017). *Evaluation of Ivy Tech's Pathways to Information Technology: Implementation and Outcomes* (Interim Report No. 2). Piscataway, NJ: Education and Employment Research Center.

[7] Edwards, et al., 2017.

TABLE 7. INTRODUCTORY-LEVEL IT COURSES OFFERED AT IVTY TECH AND THEIR INSTRUCTIONAL FORMATS BY ACADEMIC YEAR

	2014-15		2015-16		2016-17		2017 (Fall Only)		Total	
Course Name	N	%	N	%	N	%	N	%	N	%
ITSP 135	1,307	31.2	1,306	37.8	1,518	40.6	901	45.0	5,032	37.6
NETI 105	1,204	28.7	901	26.1	950	25.4	456	22.8	3,511	26.2
SDEV120	1,682	40.1	1,248	36.1	1,267	33.9	645	32.2	4,842	36.2
Instructional Format										
Traditional	1,707	40.7	1,259	36.4	1,205	32.3	646	32.3	4,817	36.0
Hybrid	852	20.3	801	23.2	882	23.6	451	22.5	2,986	22.3
Online Only	1,634	39.0	1,395	40.4	1,648	44.1	905	45.2	5,582	41.7
Total	4,193	100.0	3,455	100.0	3,735	100.0	2,002	100.0	13,385	100.0

Source: Ivy Tech administrative records data

There are slight differences in instructional mix by course type. In Table 8, we tabulate the three course titles by instructional format. First, we note that there is no hybrid version of introductory Software Development (SDEV 120). Among the courses that offered a hybrid option, use of that format was more common in IT Support (ITSP 135) than in Network Infrastructure (NETI 105). We also note that the proportion of online-only registrations across all three course types was relatively consistent, with a range spanning only 4 percentage points, from 39% to 42% of all enrollments.

TABLE 8. ENROLLMENT IN INTRODUCTORY-LEVEL IT COURSES AT IVY TECH, BY INSTRUCTIONAL FORMAT

	ITSP 135		NETI 105		SDEV 120		Total	
	N	%	N	%	N	%	N	%
Traditional	999	19.9	1,076	30.7	2,742	56.7	4,817	36.0
Hybrid	1,928	38.3	1,058	30.1	0	0.0	2,986	22.3
Online Only	2,105	41.8	1,377	39.2	2,100	43.4	5,582	41.7
Total	5,032	100.0	3,511	100.0	4,842	100.0	13,385	100.0

Source: Ivy Tech administrative records data

The data reveal troubling withdrawal numbers in online-only courses. Finally, we present a simple examination of course outcomes by instructional format. (See Table 9.) Two notable findings stand out. The first is that the great majority – 89 percent – of students passed their classes if they finished them (i.e., if they did not withdraw). The second observation is that course withdrawal was highly dependent on instructional format. When compared with traditional classroom and hybrid courses – which had nearly identical withdrawal rates hovering around 21 percent – students were far less likely to finish online-only courses (withdrawal rate 31%, Chi-Square=144.7, $p<.001$).

TABLE 9. IVY TECH IT COURSE OUTCOMES BY COURSE FORMAT

	Traditional		Hybrid		Online Only		Total	
	N	%	N	%	N	%	N	%
Passed (If Finished)	3,265	90.3	1,923	86.6	3,138	88.4	8.326	88.7
C or Better (If Finished)	2,974	82.3	1,770	79.7	2,812	79.2	7,556	80.5
Avg. Course Grade (If Finished)	2.7 (1.3)		2.7 (1.4)		2.7 (1.4)		2.7 (1.3)	
Finished Class	3,616		2,221		3,549		9,386	
Withdrawal	985	21.4	590	21.0	1,574	30.7	3.149	25.1

Source: Ivy Tech administrative records data

Who Enrolls in Online-Only IT courses?

Women, older students, and Pell recipients were more likely to enroll in online-only courses. Having established some baseline statistics and noting that withdrawal was much more likely for online-only course enrollments, we proceed to use regression methods to predict who opts to enroll in those courses. This will help us understand whether certain populations are being disproportionately affected by the diminished outcomes of the online-only format. We conduct these analyses separately by course type, then combine all courses together. Regardless of course type, we observe that women, Pell grant recipients, and older students were more likely to take online-only sections. Minority students were less likely to do so, African American students in particular. The results of this analysis are shown in Table 10.

TABLE 10. REGRESSION MODEL PREDICTING ENROLLMENT IN ONLINE-ONLY COURSE TAKING IN ITSP 135, NETI 105, AND SDEV 120.

DV= Online Course (ref: Hybrid or Traditional Course)	ITSP 135	NETI 105	SDEV 120	Combined
Gender (ref: Male)				
Female	.10 (.02)***	.06 (.02)**	.09 (.02)***	.09 (.01)***
Not Reported	-.003 (.07)	-.01 (.08)	.07 (.07)	.02 (.04)
Ethnicity (ref: White/Asian)				
Black/African American	-.12 (02)***	-.05 (.03)	-.06 (.02)**	-.08 (.01)***
Other Minority	-.06 (.03)*	-.03 (.03)	-.03 (.02)	-.04 (.02)*
No Ethnicity Reported	-.14 (.04)**	-.14 (.05)*	-.15 (.04)***	-.14 (.03)***
Socioeconomic Status				
Pell Grant Recipient	.03 (.01)*	.03 (.02)*	.04 (.01)***	.03 (.01)***
Age in 2015 (in years)	.004 (.001)***	.004 (.001)***	.01 (.001)***	.01 (.0004)***
Model R-Squared	.02	.01	.04	.02
N	5,032	3,511	4,842	13,385

Source: Ivy Tech administrative records data
*p<.05 **p<.01 ***p<.001

How does instructional format relate to course success?

Online-only courses were associated with higher IT course withdrawal rates. Across course types, there was a substantial increase in the chance of course withdrawal from online-only sections – that increase ranged from 9 percentage points in ITSP 135 to 13 percentage points in NETI 105. African American students were more likely to withdraw from their introductory-level IT courses by a rate of 8 to 12 percentage points, regardless of instructional format. Pell recipients were also significantly more likely to withdraw. This suggests that minority and low-SES student success are separate issues from course instructional format. In all three courses, older students were less likely to withdraw, and women were less likely to do so in SDEV 120. These results are shown in Table 11.

TABLE 11. REGRESSION MODEL PREDICTING WITHDRAWAL FROM ONLINE-ONLY COURSE TAKING IN ITSP 135, NETI 105, AND SDEV 120

DV= Withdrew from course	ITSP 135	NETI 105	SDEV 120	Combined
Instruction Format (ref: Traditional)				
Hybrid	.03 (.02)	-.04 (.02)*	N/A	-.01 (.01)
Online Only	.09 (.02)***	.13 (.02)***	.11 (.01)***	.09 (.01)***
Gender (ref: Male)				
Female	-.01 (.02)	.03 (.02)	-.03 (.02)*	-.03 (.01)**
Not Reported	.04 (.06)	.17 (.08)*	.03 (.06)	.07 (.04)
Ethnicity (ref: White/Asian)				
Black/African American	.08 (.02)***	.10 (.03)***	.12 (.02)***	.10 (.01)***
Other Minority	.01 (.02)	.05 (.03)	.05 (.02)*	.04 (.01)*
No Ethnicity Reported	-.07 (.03)*	-.16 (.05)**	-.10 (.04)*	-.11 (.02)***
Socioeconomic Status				
Pell Grant Recipient	.04 (.01)***	.06 (.02)***	.06 (.01)***	.05 (.01)***
Age in 2015 (in years)	-.002 (.001)*	-.002 (.001)***	-.003 (.001)***	-.002 (.0004)***
Model R-Squared	.02	.04	.03	.02
N	4,680	3,281	4,574	12,535

Source: Ivy Tech administrative records data

Pass rates were lower in online-only and hybrid courses. The following analyses are restricted to those students who completed their courses and received final grades. The first set of regression models predict the likelihood of earning any passing grade of a D or better. (See Table 12.) Students in hybrid and online-only sections who did not withdraw from their courses were generally less likely than their peers in traditional-format sections to pass their course. But the effect is not uniform across the three courses. With regard to online-only sections, the difference is modest across sections of ITSP 135 – online-only students are 3 percentage points less likely to pass – but more substantial in NETI 105, where online students were 10 percentage points less likely to pass. No significant format-based differences existed among the pass rates of SDEV 120, however, which makes sense because Software Development, like online learning itself, is accomplished in front of a computer. The analysis revealed no significant difference between the passing rates of hybrid courses and traditional ITSP 135 (IT Support) courses. This

analysis suggests that course content likely plays a role in how instructional format interacts with passing. Suggesting a distinct issue due to its reflection of earlier findings (see our discussion of Table 11), Pell grant recipients and African American students were significantly less likely to pass NETI 105 and SDEV 120.

TABLE 12. REGRESSION MODEL PREDICTING THE PASS RATE (GRADE OF D OR BETTER) OF COURSE TAKING IN ITSP 135, NETI 105, AND SDEV 120 PREDICTING COURSE PASSING (GRADE D OR BETTER)

	ITSP 135	NETI 105	SDEV 120	Combined
Instruction Format (ref: Traditional)				
Hybrid	-.01 (.01)	-.10 (.02)***	N/A	-.04 (.01)***
Online Only	-.03 (.01)*	-.10 (.02)***	.01 (.01)	-.03 (.01)***
Gender (ref: Male)				
Female	-.01 (.01)	-.01 (.02)	.01 (.01)	.01 (.01)
Not Reported	.002 (.05)	-.22 (.09)*	-.01 (.05)	-.05 (.03)
Ethnicity (ref: White/Asian)				
Black/African American	-.03 (.02)	-.06 (.03)*	-.03 (.02)*	-.03 (.01)**
Other Minority	-.003 (.02)	-.06 (.03)*	-.01 (.02)	-.02 (.01)
No Ethnicity Reported	.02 (.03)	.05 (.05)	-.06 (.03)*	-.004 (.02)
Socioeconomic Status				
Pell Grant Recipient	-.01 (.01)	-.04 (.02)*	-.03 (.01)**	-.02 (.01)**
Age in 2015 (in years)	.003 (.001)***	.003 (.001)***	.004 (.001)***	.003 (.0003)***
Model R-Squared	.01	.03	.02	.01
N	3,788	2,128	3,470	9,386

Source: Ivy Tech administrative records data

The data indicate lower course success in online-only courses as well as – and independent from – poorer performance for minority and low-SES students. The models in Table 13 redefine the grade outcome to focus on course grades that allow students to advance in course sequences – letter grades of C or better – a condition we call *course success*[8]. These results don't differ substantially from the set relative to instructional format. We observe that, overall, students in online-only and hybrid courses succeeded at lower rates than their peers in traditional-format courses. However, this correlation was not observed across all three of the course types. While differences in course success were not significant across sections of ITSP 135, all format-based differences were large and significant in NETI 105; students in hybrid courses were 10 percent less likely than those in traditional sections to achieve a successful outcome in the course, and those in online courses fared even worse – they were 15 percent less likely to succeed. Online-only course delivery had a small (.03%) but significant negative affect on SDEV 120 success outcomes. We also note that African American and other minority

[8] The definition is of 'success' – C or Better – since that typically allows students to proceed in course sequences. This differs from a simple pass, defined as D or better in Table 12.

students were less likely than their white and Asian peers to succeed (by this definition), as were Pell grant recipients. Older students, by contrast, were more likely to succeed.

TABLE 13. REGRESSION MODEL PREDICTING COURSE SUCCESS (GRADE OF C OR BETTER) IN ITSP 135, NETI 105, AND SDEV 120

	ITSP 135	NETI 105	SDEV 120	Combined
Instruction Format (ref: Traditional)				
Hybrid	.02 (.02)	-.10 (.02)***	N/A	-.03 (.01)**
Online Only	-.02 (.02)	-.14 (.02)***	.03 (.01)*	-.05 (.01)***
Gender (ref: Male)				
Female	.01 (.02)	.02 (.03)	.003 (.02)	.02 (.01)
Not Reported	-.09 (.06)	-.11 (.10)	.009 (.06)	-.06 (.04)
Ethnicity (ref: White/Asian)				
Black/African American	-.06 (.02)**	-.15 (.03)***	-.07 (.02)**	-.08 (.01)***
Other Minority	-.04 (.02)	-.09 (.04)*	-.04 (.02)	-.05 (.02)**
No Ethnicity Reported	.08 (.04)*	.01 (.06)	-.05 (.04)	.01 (.02)
Socioeconomic Status				
Pell Grant Recipient	-.02 (.01)	-.05 (.02)*	-.03 (.01)*	-.03 (.01)***
Age in 2015 (in years)	.005 (.001)***	.004 (.001)***	.01 (.001)***	.005(.0004)***
Model R-Squared	.03	.04	.03	.02
N	3,788	2,128	3,470	9,386

Source: Ivy Tech administrative records data

Negative grade associations for online-only students vary among course types. Our final set of course success analyses treats course grades as a continuous variable. A letter grade of A is given a value of 4, B a value of 3, and so on to 0 for a grade of F. These models permit the most robust analysis. (See Table 14.) Assessing instructional format, we observe that students taking online-only sections of NETI 105, provided they didn't withdraw (which many of them did), had average grades nearly 0.4 grade points lower than their peers taking NETI 105 in a traditional format. In this course, students taking hybrid sections also had lower average grades by about 0.3 grade points. This stands to reason; Network Infrastructure – which teaches students the fundamentals of installing network hardware – is and should be a hands-on course. By contrast, we observe no significant grade differences between hybrid, online-only, and traditional sections of ITSP 135. Software Development (SDEV 120) has no hybrid sections but shows somewhat lower average grades (by 0.1 grade points) in online-only sections.

The grades of minority and low-SES students (Pell recipients) were significantly lower than the grades of white and Asian students, though to different degrees depending on course type. Interestingly, female students outperformed men in sections of SDEV 120 when they finished their courses – by a difference of almost 20 percent. Older students outperformed their younger peers when they finished regardless of course type. But as we established above, both older and female students disproportionately enrolled in online-only sections and were thus at greater withdrawal risk.

TABLE 14. REGRESSION MODEL PREDICTING COURSE GRADES (4-POINT SCALE) IN ITSP 135, NETI 105, AND SDEV 120

	ITSP 135	NETI 105	SDEV 120	Combined
Instruction Format (ref: Traditional)				
Hybrid	.11 (.06)	-.28 (.07)***	N/A	.003 (.04)
Online Only	-.09 (.06)	-.36 (.08)***	-.13 (.04)**	-.13 (.03)***
Gender (ref: Male)				
Female	.09 (.06)	.12 (.08)	.19 (.05)***	.15 (.04)***
Not Reported	-.14 (.22)	-.42 (.33)	.04 (.20)	-.12 (.14)
Ethnicity (ref: White/Asian)				
Black/African American	-.25 (.07)**	-.50 (.11)***	-.40 (.07)***	-.34 (.05)***
Other Minority	-.10 (.08)	-.27 (.12)*	-.16 (.08)*	-.16 (.05)**
No Ethnicity Reported	.26 (.13)*	-.07 (.18)	-.13 (.12)	.04 (.08)
Socioeconomic Status				
Pell Grant Recipient	-.14 (.04)**	-.22 (.06)***	-.19 (.04)***	-.18 (.03)***
Age in 2015 (in years)	.03 (.002)***	.02 (.003)***	.03 (.002)***	.02 (.001)***
Model R-Squared	.04	.05	.07	.04
N	3,788	2,128	3,470	9,386

Source: Ivy Tech administrative records data

Summary. These analyses suggest that instructional format relates to student success in two key ways. First, online-only course attempts are significantly more likely to end in withdrawal before course completion. Second, when students complete online-only courses, they tend to earn lower grades than are earned by their peers in traditional-format course sections. These findings are consequential in the context of growing enrollment in online-only IT courses. It also suggests a disconnect with efforts to improve instruction with hands-on-learning. The enhancements to Ivy Tech's IT labs and equipment cannot improve hands-on instruction for students who never see the inside of classrooms.

Part 3: Beginning IT Students' Pathways

To assess the impact of the TAACCCT grant on IT student success, we also conducted a set of analyses at the student level to measure the extent to which students progressed on pathways toward IT credentials during the grant period. To make theoretically consistent estimates, we selected students who first enrolled in the 2014–15 or 2015–16 academic years who had declared an IT field of study.

Table 15 describes the outcomes we used to assess student pathways in the Ivy Tech program. To make these analyses meaningful and consistent across students, we focus on first-time students pursuing associate degrees in TAACCCT fields of study. We define a *Level-1 IT Milestone* as completion of one course from the list of introductory courses shown in the table. We define a *Level-2 IT Milestone* as the completion of any course from the list of IT courses in row 2 – courses that indicate students have chosen a more specific IT field of study. The courses

listed in row 3, *IT-Required Math*, are math courses required for advancement in one or more IT fields of study. In addition to these milestone outcomes, we also assess continuous enrollment in a student's first year, total credits earned, and IT-specific credits earned. Each of these outcomes is assessed three terms and six terms after initial enrollment.

TABLE 15. DEFINITIONS OF DICHOTOMOUS OUTCOMES

Outcome	Definition
Level-1 Milestone	Completion of one or more of the following courses: ITSP 135, INFM 109, DBMS 110, SDEV 120, NETI 100, NETI 105
Level-2 Milestone	Completion of one or more of the following courses: INFM 209, INFM 219, CSIA 105, CSIA 106, SVAD 111, SVAD 112, NETI 120, NETI 205, DBMS 210, DBMS 230, DBMS 240, DBMS 250, DBMS 255, ITSP 136, ITSP 135, CSCI 101, CSCI 102, CSCI 105, SDEV 140
IT-Required Math	Completion of one or more of the following courses: MATH 123, MATH 135, MATH 136, MATH 137, MATH 211, MATH 212
Continuous Enrollment	Credit-earning in both the Fall and Spring terms of a student's first year.

Source: Ivy Tech program documents, interviews with college staff

First-time degree-seeking IT students had similar traits over time. Table 16 displays descriptive characteristics of the group of students included in the pathways analysis. To assess the effects of the TAACCCT grant on pathways outcomes, we first assess what – if any – differences existed among entering cohorts by term. All term cohorts were similar relative to gender and ethnicity. Students who entered in Spring terms were on average older and more likely to be veterans. The latest cohort analyzed here – Spring 2016 – had the lowest proportion of Pell recipients. Over the course of the four terms, the largest proportions of entering students chose IT Support or Software Development as their fields of study.

TABLE 16. DEMOGRAPHIC DESCRIPTION OF COHORTS: FIRST-TIME, DEGREE-SEEKING STUDENTS IN IVY TECH IT PROGRAMS

First Time Student in…	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Combined
Gender					
% Male	81.3	80.7	78.6	80.5	80.3
% Female	18.1	18.7	19.8	18.8	18.9
% Not Reported	0.6	0.6	1.6	0.7	0.9
Age					
Mean	27.3	28.6	26.4	28.2	27.4
Race/Ethnicity					
White/Asian	73.3	73.6	73.1	72.4	73.2
Black/African American	15.2	16.9	12.9	13.8	14.6
Other Race Categories	9.6	8.5	9.5	8.1	9.1
Unknown	1.9	1.0	4.5	5.7	3.2
Socioeconomic Status					
% Pell Recipient	66.4	68.5	62.6	56.6	64.0
Other Characteristics					
% Veteran	9.1	10.8	7.9	9.5	9.1
IT Program of Study at Entry					
Computer Science	27.6	26.2	28.4	31.0	28.1
Cyber Security/Info Assurance	7.6	8.7	11.2	9.1	9.1
Database Management	4.7	5.1	4.3	4.1	4.5
Informatics	6.2	8.5	6.4	7.9	7.0
IT Support	20.4	21.1	17.3	13.4	18.4
Network Infrastructure	4.6	4.7	4.8	3.6	4.5
Software Development	24.0	21.1	24.1	29.0	24.3
Server Administration	5.0	4.5	3.6	2.0	4.0
N	877	492	751	442	2,562

Source: Ivy Tech administrative records data

Three terms later: Student progress is accelerating over time. We analyze student outcomes at three (Table 17) and six terms (Table 18) after entry, inclusive of summer terms. After three terms, first-time students at Ivy Tech accumulated an average of 10.6 credits, of which 4.5 were in IT courses. Both the average number of credits earned and the proportion of credits earned in IT increased over time, though students who began in Spring terms earned fewer credits overall than those who started in Fall terms. Examining the completion of milestone and required mathematics courses, we observe the same pattern of increase over time. While only 40 percent of Fall 2014 entering students completed a Level-1 Milestone, that proportion rose to 52 percent by Fall 2015/Spring 2016. The most significant obstacle for IT students appears to be required mathematics; even while the overall proportion has increased, less than 20 percent of students had completed any required math course after three terms. The proportion of students continuously enrolled in their two terms (Fall or Spring for this outcome) declined slightly among fall-term starters but rose from 48 to 55 percent among spring-term starters.

TABLE 17. TAACCCT PATHWAYS: OUTCOMES (CREDITS EARNED, MILESTONES REACHED, AND CONTINUOUS ENROLLMENT) AFTER THREE TERMS

First time student in…	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Combined
Continuous Outcomes—Means Reported					
Total Credits Earned	10.9	9.3	11.3	10.3	10.6
IT Credits Earned	3.9	4.1	5.3	4.9	4.5
Dichotomous Outcomes—Proportions Reported					
% Any Level-1 Milestone	40.4	43.1	52.9	51.8	46.5
% Any Level-2 Milestone	21.1	22.8	29.8	28.1	25.1
% Any IT-Required Math	18.5	16.7	22.0	17.2	18.9
% Continuous Enrollment	70.4	48.4	68.2	55.0	62.8
N	877	492	751	442	2,562

Source: Ivy Tech administrative records data

Six Terms Later: Student progress tapers over terms, but results are improving over the grant period. We also examine student progress at six terms – two academic years – after their first enrollment. Student progress in this second period of three terms is much more halted. This appears largely driven by retention; of six possible terms, entering students had enrolled for less than three terms on average. After earning 10.5 credits in their first three terms, the average student earned only an additional 5.8 – reaching a mean of 16.3 credits earned after six terms. There appears to be progress made over time; students who started in Fall 2014 earned 5.6 additional credits on average, and those who started in the Fall 2015 term earned an additional 6.3 credits.

TABLE 18. TAACCCT PATHWAYS: OUTCOMES AFTER SIX TERMS

First time student in…	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Combined
Continuous Outcomes—Means Reported					
Total Credits Earned	16.5	13.8	17.6	16.1	16.3
IT Credits Earned	6.5	6.4	7.8	7.8	7.4
# of Terms Enrolled	2.7	2.6	2.8	2.8	2.7
Dichotomous Outcomes—Proportions Reported					
% Any Level-1 Milestone	47.6	48.2	57.9	56.8	52.3
% Any Level-2 Milestone	30.6	28.7	38.1	37.6	33.6
% Any IT-Required Math	25.3	22.4	29.4	27.2	26.3
N	877	492	751	442	2,562

Source: Ivy Tech administrative records data

In terms of milestone completion, there was a similar tapering-off of student's attainment; but we also observe progress over time. Between three and six terms, completion of IT-required math courses rose from 19 to 25 percent among Fall 2014 starters - a seven-percentage-point increase. Among Fall 2015 starters, this figure rose from 22 to 29 percentage points – the same seven-percentage-point increase. By contrast, among Spring 2014 starters, the

proportion change between three and six terms rose by 5 percentage points (17% to 22%), while the increase for Spring 2015 starters was 10 percentage points (17% to 27%).

Students' use of their enrolled time appears to be more efficient in later program years. The results of the preceding pathways analysis suggest that the TAACCCT program appears to be focusing IT students on their progress toward credentials. In both the three-term and six-term analyses, the indicators of time enrolled (i.e., continuous enrollment in year one, total terms enrolled out of six) appear relatively constant. But the measures of credit accumulation, and more specifically those measuring IT-specific attainment (both credits and milestones) rose between the 2014-15 and 2015-16 academic years. This suggests that IT students are more efficiently using the time they spend enrolled. It may be that increasing the duration of student enrollment is a separate puzzle to be solved, but from what we observe, it seems the TAACCCT program's focus on student pathways has paid off in terms of students use of the time they do spend enrolled.

Part 4: Quasi-Experimental Pathways Analysis

The following analyses attempt to assess the effectiveness of the TAACCCT program interventions by comparing Ivy Tech IT students (the TAACCCT group) to Ivy Tech students pursuing coursework and credentials in Advanced Manufacturing (the comparison group). Throughout this section, we use the term 'Advanced Manufacturing' to indicate a group of major fields of study that includes: Biotechnology (BIOT); Electrical Engineering Technology (EECT); Engineering (ENGR); Engineering Technology (ENGT); Mechanical Engineering Technology (METC); and Nanotechnology (NANO).

The outcomes in these analyses are similar to the findings discussed in the analyses of student pathways in Part 3 of this report. As such, we restrict the analytic sample to students who first took courses at Ivy Tech in either Fall or Spring semesters of the 2014–15 or 2015–16 academic years, which allows us to track those students' outcomes for six terms.

On average, TAACCCT student outcomes were better than those of comparison group students. Table 19 describes the demographic and student-performance characteristics of students in the comparison group (advanced manufacturing) and TAACCCT group (Information Technology). Compared with the students in the comparison group, students in the TAACCCT group were more likely to be female, more likely to be white or Asian, and significantly older by 2.5 years. However, when we observe student performance data, we see statistically significant differences between the two groups in the total number of terms students remained enrolled and in their overall credit earning at both three and six terms. Much more substantial differences are observed between groups when we look at mean credit earning in students' major field of study at both time points.

TABLE 19: DEMOGRAPHIC AND ENROLLMENT CHARACTERISTICS AND PATHWAYS OUTCOMES OF FIRST-TIME MANUFACTURING (COMPARISON) AND IT (TAACCCT) STUDENTS, 2014–15 AND 2015–16 ACADEMIC YEARS

	Comparison Group (N=1,933)		TAACCCT Group (N=4,806)	
	#	%	#	%
Gender				
Male	1,572	82.0	2,903	76.0
Female	319	16.6	857	20.5
Not Reported	26	1.4	55	1.4
Ethnicity				
White/Asian	1,355	70.7	2,760	72.4
Black/African American	269	14.0	559	14.5
Other Ethnic Groups	224	11.7	338	8.9
No Ethnicity Data	69	3.6	158	4.1
Age in 2015				
Mean (sd)	25.3 (7.8)		27.9 (10.2)	
Dichotomous Outcomes				
Continuous Enrollment in First Two Semesters	997	51.6	2,732	56.9
Continuous Outcomes				
# of Terms Enrolled of First Six Potential*	2.3 (1.4)		2.8 (1.5)	
Total Credits Earned After Three Terms*	10.0 (11.0)		10.8 (9.3)	
Total Credits Earned After Six Terms*	13.6 (16.4)		16.8 (16.5)	
Major Area Credits Earned After Three Terms*	1.1 (2.7)		4.1 (6.0)	
Major Area Credits Earned After Six Terms*	1.8 (4.5)		6.7 (9.9)	

Source: Ivy Tech administrative records data; *p<.05

Some of the difference in performance is explained by differences in gender, race, and age. Having established baseline differences between the TAACCCT and comparison groups, we then used traditional linear regression models to examine the relationship between student demographic and enrollment characteristics and pathways outcomes. We present the results of these analyses in Table 20. In these models, we find significant differences between the two groups on continuous enrollment and on all four credit-earning outcomes. As with other data analyzed in this report, we find that female students are generally outperforming their male peers, with the exception of credit earning in their major area (IT or Advanced Manufacturing). African American and other minority students in these data also appear to be performing relatively poorly. A student's term of first enrollment also matters for student performance; we observe large and statistically significant differences between Fall and Spring starters. However, as noted above, the TAACCCT and comparison groups differ in some noticeable and statistically significant ways; we therefore utilize propensity score matching to obtain more precise estimates of the differences between the two groups.

TABLE 20. REGRESSION MODELS PREDICTING COHORT ENROLLMENT (TAACCCT/IT VS. ADVANCED MANUFACTURING) AND PATHWAYS OUTCOMES

Outcome →	Continuous Enrollment (Probability)	Number of Enrolled Terms	Credits Earned – 3 Terms	Credits Earned – 6 Terms	Major Credits Earned	Major Credits Earned
IT Student (ref. Adv. Mfg.)	*12.2*** (1.2)*	*0.5*** (.04)*	*0.8** (0.3)*	*3.1*** (0.5)*	*2.8*** (0.1)*	*4.6*** (0.2)*
Gender (ref. Male)						
Female	5.3** (1.6)	0.2*** (.05)	0.8* (0.3)	1.6** (0.5)	-0.2 (0.2)	-0.4 (0.3)
Not reported	-3.0 (5.9)	-0.2 (0.2)	-3.4** (1.2)	-6.2** (2.0)	-0.9 (0.6)	-2.0* (1.0)
Ethnicity (ref. White/Asian)						
Black/African American	-6.4*** (1.8)	-0.2*** (0.1)	-2.6*** (0.4)	-3.9*** (0.6)	-1.5*** (0.2)	-2.1*** (0.3)
Other ethnicity	-7.5*** (2.2)	-0.2** (0.1)	-1.4** (0.4)	-2.4*** (0.7)	-0.8** (0.2)	-1.4*** (0.4)
No ethnicity data	-0.7 (3.6)	-0.1 (0.1)	1.3 (0.7)	1.9 (1.2)	-0.04 (0.3)	-0.4 (0.6)
Student Age in 2015	0.2** (0.1)	.001 (.002)	-.03* (.01)	-.05* (.02)	.06*** (.01)	.08*** (.01)
First Term (ref. Fall 2014)						
Spring 2015	-18.3*** (1.8)	-0.1* (.05)	-1.4*** (0.4)	-2.2*** (0.6)	-0.001 (0.2)	-0.3 (0.3)
Fall 2015	-2.0 (1.6)	0.05 (.05)	0.1 (0.3)	0.2 (0.5)	0.8*** (0.2)	1.1*** (0.3)
Spring 2016	-16.5*** (1.9)	-0.1 (.06)	-1.0* (0.4)	-1.5* (0.7)	0.7*** (0.2)	1.0** (0.3)
R-Squared	.048	.033	.018	.024	.098	.087
N	5,731					

Source: Ivy Tech Administrative Records Data, *p<.05**p<.01***p<.001

A propensity score analysis reveals that TAACCCT-supported IT students outperform the comparison group overall. We utilized propensity score matching – a statistical technique that attempts to balance student characteristics across groups in order approximate the conditions of a randomized controlled trial – to better estimate TAACCCT program impacts. In Appendix Table B we include the first-stage propensity model, which uses regression to predict students' odds of being a part of the TAACCCT group based on their observed characteristics. The propensity score is a single number that represents these odds and is used to match students in the TAACCCT group to similar students in the Advanced Manufacturing Comparison group. Those matched groups are then compared on the specified outcomes. The adjusted results (presented in Table 21) are not substantially different overall from the correlations obtained by ordinary regression techniques. This provides further evidence to suggest that the TAACCCT students outperformed the comparison group on credit attainment, particularly over six terms. It is important to keep in mind, however, that differences may fail to

emerge for two reasons related to data limitations: 1) an insufficient sample size in the control group, which limits the effectiveness of matching, and 2) the fact that we did not have enough pre-treatment demographic data to create a robust matching model.

TABLE 21: PROPENSITY-SCORE-MATCHED OUTCOMES (N=5,727) COMPARING TAACCCT/IT VS. ADVANCED MANUFACTURING WITH PATHWAYS OUTCOMES

	Treatment Group Mean/Proportion	Control Group Mean/Proportion	Mean/Proportion Difference
% Continuously enrolled	63.7	51.1	12.5**
Number of terms enrolled (out of six)	2.8	2.3	0.5***
Total credits earned after three terms	10.8	9.7	1.1*
Total credits earned after six terms	16.8	13.1	3.7**
Major area credits earned after three terms	4.1	1.2	2.9***
Major area credits earned after six terms	6.7	1.9	4.9***

Source: Ivy Tech Administrative Records Data, *p<.05 **p<.01 ***p<.001

The evidence was unclear on the number of major-area credits. On average, Advanced Manufacturing students earned far fewer credits in their major area than did IT students, even though both groups had similar levels of total credit earning in the same period. One explanation for these differences may be measurement error. We do not believe this is the case; we defined major-area credits as all credits earned in courses in subject areas related to Advanced Manufacturing fields – the same procedure we used to classify IT credits earned. Another explanation is conceptual. These results may suggest that our understanding of student pathways through Advanced Manufacturing programs is limited or incomplete. But absent a strong theoretical explanation of the differences, we are cautious to interpret these latter observed differences as evidence of the effectiveness of the TAACCCT intervention.

Otherwise, there do appear to be substantial overall differences between the intervention and comparison groups. Thus, our final quasi-experimental analysis utilizes a difference-in-difference model (DID). DID models ask whether the changes that occur as the result of an intervention are in excess of secular trends occurring over time. Such a model is a good choice when differences between intervention and comparison groups are already apparent. As with the propensity score models presented above, these DID models are adjusted for students' gender, ethnicity, and age.

Differences in outcomes across TAACCCT and control groups are not significant using difference-in-difference analysis. Table 22 presents three sets of analyses – a test of baseline mean differences, a test of mean differences in the follow-up period, and a significance test for the difference between those two observed differences (the DID) – for each of four student outcomes. With the exception of credits earned after three terms, we see significant baseline and follow-up-period differences that favor the TAACCCT group. IT students were more likely to

continuously enroll, enrolled for more terms overall, and earned more credits at the end of six terms in both periods. But the differences observed did not change over time. If anything, the differences between the TAACCCT and Comparison groups appear to narrow. Thus, the difference-in-difference analyses do not suggest a strong program effect on student outcomes.

TABLE 22. DIFFERENCE IN DIFFERENCE CALCULATIONS FOR SELECTED OUTCOMES

Outcome Variable	Baseline Period (2014-15 Academic Year)			Follow-Up Period (2015-16 Academic Year)			Difference in Difference
	Comparison Group	TAACCCT Group	Baseline Difference	Comparison Group	TAACCCT Group	Follow-Up Difference	
% 2-term continuous enrollment	49.5	62.2	12.7 (1.8)***	49.6	61.3	11.7 (2.0)***	-1.0 (2.7)
# of terms enrolled out of 6	1.8	2.3	0.49 (0.06)***	1.8	2.4	0.50 (0.06)***	0.01 (0.09)
3-term credits earned	6.49	7.35	0.87* (0.37)	6.87	7.49	0.61 (0.42)	-0.26 (0.56)
6-term credits earned	7.13	10.34	3.21 (0.61)***	7.61	10.69	3.08 (0.70)***	-0.13 (0.92)

Source: Ivy Tech Administrative Records Data, *p<.05 **p<.01 ***p<.001

Summary. We attempted to assess program effects in three ways: a comparison of two cohorts of IT students, a contemporary comparison of IT students with students in other programs (Advanced Manufacturing), and a difference-in-difference analysis which combines the two. The first analysis indicated that IT students who began their programs of study during the TAACCCT program (2015-16) outperformed those who enrolled prior to the full rollout of the program (2014-15). This suggests that the changes affected by the program had a positive impact on student progress, which we describe as more efficient use of enrolled terms. The contemporary comparison to Advanced Manufacturing students similarly showed that IT students were outperforming their peers in these other programs. But there appear to be substantial differences between the IT student population and the Advanced Manufacturing comparison group – both in terms of demographic traits (i.e., age and gender) and attainment of the student pathways outcomes (i.e., major area credits and milestone courses). Given this, our assessment of program effects from these comparisons may not be accurate. Further, the propensity score models for this comparison lacked a robust set of covariates to create the best possible matched groups. Thus, we adopted a difference-in-difference strategy, which allows for comparison of groups with different baseline characteristics, to instead assess whether the between-groups gaps we observed in our contemporary comparison analysis grow over time.

By that metric, our DID analysis did not find any significant effects, with the same caveat regarding student-level covariates.

We interpret these findings with care. On the one hand, we hesitate to interpret the propensity models as evidence of a program effect given the apparent dissimilarity of the students in the IT and Advanced Manufacturing program groups. On the other hand, despite the null findings in the difference-in-difference models, we still observe in the initial pathways analysis that IT students did better over time. What we know about the TAACCCT program suggests that it would have impacted students' performance in the ways we observed – more credentials earned, more IT-specific credits earned, and more efficient use of enrolled terms. The null findings of the difference-in-difference models raise the question of whether there were other college-wide changes at Ivy Tech that may have boosted the performance of both IT and non-IT students.

CONCLUSION

The TAACCCT grant at Ivy Tech served as a springboard for broad institutional change. Prior to the grant, institutional goals were identified and planned for, but funding was needed to prioritize and execute some them. The grant award allowed Ivy Tech to realize these goals, and the grant period saw substantial institutional change – some occurring coincidentally but coinciding with the grant, which created positive reinforcement of the grant's goals, and others occurring as a direct result of grant planning and execution. Ivy Tech's TAACCCT goals focused on building and strengthening the college's IT pathways, and the college took a multifaceted approach to reaching those goals. Grant implementation ultimately included numerous elements: a realignment and restructuring of the advising model; a central focus on educational and career pathways; a restructuring of the Information Technology program to increase its program offerings from four fields of interest to eight; a focus on professional certifications and professional development training for faculty members; a structural change to move the Computing and Informatics (CPIN) programs to a newly formed 'School of Information Technology' at each campus; a focus on hands-on learning accompanied by an influx of equipment and supplies as well as the remodeling of space on several campuses; a reinvigoration of employer relationships to renew Ivy Tech-industry collaboration; and the development of IT competitions to enrich the student experience.

Ivy Tech was able to complete so much institutional change with one grant and in such a short period of time for several reasons. First, the many and varied goals ultimately addressed using grant funds had been conceived before and independent from the TAACCCT award, and the grant was written expressly to support those goals. The grant aligned well with Ivy Tech's institutional priorities and served as a catalyst for change by either providing the needed funding or the focus to see the college's vision become reality.

Second, the school was able to use the statewide structures – and staffing – already in place without hiring many new staff members. A program manager, some lab assistants, and a

consultant were hired, but all other staffing requirements were met by existing faculty and staff members. Faculty chairs became site coordinators and oversaw the day-to-day grant activities on their respective campuses. Faculty members became faculty champions and helped train other faculty members in industry certifications, as well as spread positivity among faculty relative to hands-on learning, educational and career pathways, and industry certifications. Student interns became temporary (honorary) "staff members" and helped create elements of the advising tool, working on software programming, data entry, and video creation. Students taking courses when the new equipment and supplies were delivered helped set up and install it, troubleshooting issues and physically assembling the parts. The school was able to save money by utilizing existing staff and students, and the cohesion and collaboration likely fostered positivity and kept the extensive changes moving forward.

Third, the program manager hired to oversee grant activities was able to provide leadership, troubleshoot problems as they arose, and coordinate statewide activities. Having one person in charge of the grant's activities at the state level helped to ensure consistency of implementation and ensured follow-through on grant goals. The program manager was able to effectively develop relationships with key faculty and staff at the local campuses to implement grant activities and align them with existing interests. The identification of these staff and coordination of their efforts was an important role for the program manager in building an effective system for grant implementation on a statewide level. Additionally, the program manager had the vision and initiative to develop grant activities to their fullest potential and to take advantage of opportunities for their further development. Specifically, relative to professional development, when the opportunity to develop stronger relationships with industry vendors arose, the program manager pursued those relationships and created the faculty champion model.

Finally, though several of Ivy Tech's large institutional goals did not rely on funding from the grant, some reaped its benefits regardless as a result of the programmatic and other changes brought about by grant activities. For example, the change from the CPIN programs to the School of Information Technology at each campus was not a part of the grant proposal, nor did it rely on funding from the grant. However, this shift was helped by the grant's focus on educational and career pathways, hands-on learning, industry relations, and the capacity expansion of the eight programs, all of which made the institutional function of the programs stronger and more cohesive. Leadership was able to leverage the success of the grant in building buy-in to the college's IT programs and creating structural change.

Whether these changes will persist after the end of the grant is an important consideration. Many of the changes will persist or have the potential to be sustained. Some will require more ongoing support if they are to remain part of the college's IT programs. Supplies provided an enduring change on the college campuses but will require ongoing maintenance. The supplies that have been installed on campuses throughout the state have provided a significant upgrade in hands-on learning opportunities available to students. However, concern exists among faculty and staff about the ever-changing nature of the IT field and its impact on

sustainability. Because technology can change so quickly, there is a concern that equipment and supplies will soon become outdated, and because it is costly to replace, programs may be without state-of-the-art technology once again in the not-distant-enough future. Campuses are planning for the need to update equipment and supplies, however, by increasing enrollment capacity and developing alternative means of instruction, such as through the use of emulators. Campuses are also cultivating strong industry relations, which often result in donations of equipment and supplies.

Several reform areas are likely to continue, particularly with the support of ongoing college-level efforts. The grant developed a structure for industry certification training through the role of the IT faculty champions. This structure may persist past the grant period if the college continues to prioritize and coordinate this work at a statewide level. Absent the statewide support of these efforts, the work of the champions may persist on a case-by-case basis, depending faculty interest. Work on advising and pathways reform continues on a larger scale throughout the college, as well as within the School of Information Technology, so the efforts that were launched as part of the grant will continue to be built upon. Likewise, employer engagement efforts are expected to continue on behalf of the School of Information Technology and its students.

Concern exists about the sustainability of the IT competitions. Although the cost for these competitions is relatively low ($10,000 per event), the school cannot afford to support them using donations or grant funding. In addition, a consultant was hired to help organize and structure the competitions, and retaining those services may not be possible without grant funding. The college will need to consider how to run the event without the consultant. If the college can continue to generate donations, it can help sustain this effort. However, staff are necessary to obtain the donations and coordinate the effort.

Overall, Ivy Tech accomplished numerous changes during the grant period – some of which coincided with the grant coincidentally but were positively impacted by it, and others that occurred as a direct result of the grant. The shift to a new, student-focused mentorship model of advising and the institutionalization of education and career pathways will certainly serve as a catalyst for continued student outcomes and strong industry relations in the future. The TAACCCT grant, coupled with strong institutional vision, created sustainable change at Ivy Tech. Further analysis will be able to fully examine the actual long-term impacts of these changes on students.

APPENDIX A: SURVEY RESPONSES

Table A.1: *Summary of Survey Responses, Year 1*

	CPIN Student Survey	Hands-on Learning Student Survey	Faculty Survey
Number of respondents in the sample	8,541	1,373	138
Final response rate	8.7%	11.2%	60%
Number of partial completers	94	5	4
Final response N	N=746	N=155	N=83
Number who did not consent to survey	N=6	N=4	N=0
Final analysis N**	N=740	N=151	N=83
Date of initial launch	2/11/16	2/29/16	3/10/16
Date of reminder #1	2/16/16	3/3/16	3/15/16
Date of reminder #2	2/18/16	3/15/16	3/22/16
Average length of time for survey completion (excludes outliers)	7 minutes, 9 seconds	2 minutes, 17 seconds	8 minutes, 46 seconds

Note: Students and faculty were able to skip question categories; therefore respondent sizes differ across individual questions in the surveys.

Appendix A.2: ***Summary of Survey Responses, Year 2***

	CPIN Student Survey	Hands-on Learning Student Survey	Faculty Survey
Sample/Audience Size	25,026	5,530	190
Final response rate	4%	6%	55%
Final analysis N (excluding those who refused to participate, duplicates, and incomplete responses)**	N=1,014	N=331	N=87
Date of initial launch	11/29/16	1/31/17	11/29/16

Note: The Round 2 CPIN Student Survey was originally sent out in two parts—the first was the general survey sent out to a student sample, and the second was the HOL survey sent afterwards to a smaller subsample of the general survey. A second reminder to take the general survey was sent to the noncompleters. There was also a second round of surveys fielded, which combined the general survey and HOL survey, and was sent out as one survey to an additional sample of students. For much of our analysis, we combined all of the valuable data from each fielded survey (excluding missing or incomplete responses) for a total, final-analysis N of 1,014. The faculty survey was sent out once to a sample of faculty. **Students and faculty were able to skip question categories and any question they did not want to answer; therefore, respondent sizes differ across individual questions in the surveys.

Table A.3: ***Summary of Survey Responses, Year 3***

	CPIN Student Survey	Faculty Survey
Number of respondents in the sample	20,299	138
Final response rate	4.1%	33.3%
Final response N	N=833	N=46
Number who did not consent to survey	N=29	N=0
Final analysis N**	N=804	N=46
Date of initial launch	1/22/18	1/22/18
Date of reminder #1	1/29/18	1/29/18
Date of reminder #2	2/5/18	2/5/18
Date of reminder #3	3/22/18	2/13/18
Average length of time for survey completion (excludes outliers)	6 minutes, 57 seconds	7 minutes, 30 seconds

Note: Students and faculty were able to skip question categories; therefore respondent sizes differ across individual questions in the surveys.

APPENDIX B. PROPENSITY SCORE MATCHING BALANCE STATISTICS

Independent Variable	Coefficient	Standard Error	% Bias Pre-Matching	% Bias Reduction
***Gender* (ref: male)**				
Female	0.2**	0.1	9.5	-44.2
Not Reported	0.7	0.6	9.3	82.1
***Ethnicity* (ref: White/Asian)**				
Black/African American	-0.04	0.1	2.9	-20.7
Other Ethnicity	-0.3*	0.1	8.6	45.9
No Ethnicity Data	0.1	0.2	9.0	76.4
Age in 2015	.03***	.003	4.0	-57.3
***First Enrolled Term* (ref: Fall 2014)**				
Spring 2015	0.09	0.1	7.7	-1.0
Fall 2015	0.01	0.1	5.1	-56.2
Spring 2016	0.1	0.1	12.2	63.5
N	5,727			

Source: Ivy Tech Administrative Records Data, *p<.05 **p<.01 ***p<.001

Note: Race*Gender Interactions also included in the propensity score model predicting treatment