Developing Career Pathways to Data Center Operations Through High School Summer Bridge Programs

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Abstract

Data centers are large, centralized clusters of computing hardware. Enterprise and economic activities that rely on internet services (e.g., cloud-based computing, online commerce, video and audio streaming) require significant data center infrastructure to ensure continuity of services. To provide these services, data centers require significant capital investment, ongoing operational maintenance, and the engineering workforce capacity to support continued growth. Northern Virginia in particular has the largest data center footprint of any region in the world, and strong demand for a skilled technical workforce means the industry has ongoing difficulties reaching talent. Data center capacity is forecasted to double in Virginia during the next 10 years, with most of that growth concentrated in regions of Loudoun County and Manassas [1], [2]. The jobs created as a result of these investments offer high salaries for entry level technicians, especially compared with other regional opportunities to 2-year degree holders [3], [4]. Despite attractive wages and a growing field, student and educator awareness of the industry remains low, with the sector operating invisibly to most stakeholders [5].

This paper reports on project results from Northern Virginia Community College's (NOVA) engineering technology summer bridge program focused on Data Center Operations (DCO) and semiconductor manufacturing. This 2-week program for high school juniors and seniors seeks to increase recruitment towards careers in the data center industry. Over these two weeks, students complete introductory hands-on labs in engineering technology, spend two days onsite at data center partner STACK Infrastructure, and earn their OSHA 10 certification. Using quantitative and qualitative survey data from three cohorts of bridge program participants, this paper investigates the extent to which student participation in the program improved their knowledge of data center careers, important industry skills, and the educational pathways required to obtain those careers. These results are then generalized to practitioners with an interest in improving high school student recruitment into new and emerging technological fields.

Background

The onset of COVID-19 instigated a cultural shift that necessitated working from home, the impact of which remains to this day. With a larger percentage of the workforce working remotely or hybrid, cloud-based computing, online commerce, and information storage are higher than ever. In a world that is becoming increasingly reliant on technology to compute and store information, data centers are pivotal to the technology information landscape. With the increased reliance on data centers comes a need for trained and skilled technicians in the Engineering Technology field to meet the rising demand.

The Data Center Operations field is currently experiencing a rapid upswing in needed positions. Researchers estimate Data Center in North American to see a net growth of approximately ~85 thousand jobs in the next few years. Of the jobs in the data center sector, 85% of these jobs are in operations, and the maintenance of the centers themselves [6]. While the number of jobs in data center operations is continuing to rise, the number of qualified staff to fill the positions does not appear to be keeping up. I-Masons estimate upwards of 100 thousand vacant jobs in data center operations in the next few years [7]. In a survey of data center owners and operators, 1 in 5 respondents pointed to the lack of hiring and retaining qualified staff as the single largest challenge moving forward [8], [9].

To combat the rising need for qualified DCO staff, community colleges in Texas [10] and Virginia [11] have started to create outreach programs by connecting with industry partners. From a logistics perspective, this makes sense as Engineering Technology is one of the largest groups of STEM students that enroll in community college. Associate degrees are outpacing the 4 -year colleges in enrollment of engineering technology [12]. However, there is still a significant lack of awareness of the industry on the part of students and faculty, both in differentiating engineering and engineering technology, as well as in legitimizing the engineering technology field [5], [13]. This study aims to fill this gap in the literature by examining student perspectives of engineering technology to improve outreach.

Methods

Summer DCO Bridge Program Design

The summer DCO bridge program was designed to raise awareness of engineering technologies, and omitted remedial coursework and college coursework like those found in more traditional bridge programs [14]. It was funded by a National Science Foundation (NSF) Advanced Technology Education (ATE) grant. The bridge program was hosted at four of NOVA's campuses over the two years, with students being provided transportation between campuses during their program. The program took place over eight days in the summer and served were rising seniors and recent graduates, with an emphasis in recruiting students that are traditionally underrepresented in ET fields. The primary activities of the program consisted of a combination of hands-on learning and industry site visits. Hands-on learning activities included modules on pneumatic controls and industrial controls, with students controlling valves, sensors, and logic controllers to investigate closed systems. Through participation in the program, students also had the opportunity to earn 2 credits, one credit student development course and an opportunity to earn a credit for prior learning by earning an industry certification in OSHA 10.

Program Demographics

Across the three offerings of the bridge program, 67 students participated in the program. Students were either rising seniors or about to enter college and were a predominantly male (N=40) and Asian (N=25), which is also depicted in Table 1. The bridge program was successful in its efforts to recruit students that were traditionally underrepresented in ET fields, included participants from various ethnic backgrounds, with 15 students identifying as Black or African American, 14 identifying as Hispanic or Latino, and 1 student identifying as American Indian or Native Alaskan.

Table 1. Bridge program participant demographics

Participant Demographics	N	Percent
Gender		
Male	40	59.7
Female	27	40.3
Ethnicity		
White	12	17.9
Asian	25	37.3
Hispanic or Latino	14	20.9
Black or African American	15	22.4
American Indian or Alaska Native	1	1.5
Total	67	

Data Collection

Data was collected via students at the end of the bridge program via an online survey. The survey consisted of 27 questions with both Likert-scale and short answer responses. The researchers left the room while the survey was conducted to mitigate the influence of the researchers on the study's results. The survey consisted of multiple sections, including program evaluation, student perceptions of industry skills focused on OSHA 10, college success skills, and understanding of the broader ET field. Likert-like responses were rated on a 5-point scale, from Strongly Disagree (1) to Strongly Agree (5).

Data Analysis

Data analysis was conducted via both qualitative and quantitative methods. Qualitative data from student short responses was thematically coded via inductive coding, while quantitative data from Likert-like scales was analyzed via the Mann Whitney U Test to examine pre and post differences in student perception. Inductive thematic analysis is a method of coding that is data-driven, meaning the codes are strongly linked to the data themselves [15], [16]. Inductive coding was used because limited research has been conducted on student perceptions of engineering technology and engineering. Mann Whitney U test is a non-parametric test used to compare the means of two samples from the same populations [17]. The Mann Whitney U Test is often used with ordinal data, such as a Likert-like scale, when the differences between intervals is not known [18]. Researchers used a 2-tailed hypothesis to calculate Z-scores so as have no underlying assumptions of the data and it's directionality.

Results

Knowledge of Engineering Technology and Data Center Operations

To ascertain student understanding of the Data Centers and the larger Engineering Technology field, students were asked to both define the field of Engineering Technology and to differentiate it from the field of Engineering. Student responses, while varied, revolved largely around the idea that engineering technology is more "hands on" and focused on "application and implementation" while engineering placed more emphasis on "research" and "developing and designing." Of the 21 students who answered this question, 14 gave responses that differentiated engineering and engineering technology in a similar way, three participants had "no idea" what the difference was, and three respondents said that engineering technology was "interesting."

To triangulate these findings, students were also asked about how their participation in the bridge program affected the understanding of engineering technology and data center operations, which are detailed in Table 2. Across all six areas, students rated that they had an increase in understanding across all six areas. No question had more than two students 'disagree' or 'strongly disagree' that the bridge program increased their understanding.

Table 2. Summary of student understanding of ET and DCO fields

Participating in the Summer Bridge Program increase my understanding of the…	**Mean**	**Std Dev.**	**Responses**
Engineering Technology (ET) Field	4.11	0.80	26
Types of ET careers	4.16	0.80	41
Types of Data Center Operations (DCO) careers	4.20	0.71	41
Types of ET degrees and certifications	4.18	0.81	41
Skills required for ET careers	4.04	0.85	41
Skills required for DCO careers	4.15	0.72	41

Knowledge of Important Industry Skills

Mann Whitney U tests indicated that the bridge program students felt they had a better understanding of various Engineering Technology industry-related skills. The list of skills that were rated were informed by the OSHA 10 certification that students completed as a part of the bridge program. Across all eight of the skills, Students rated significantly higher scores after participation in the bridge program when compared to before. The detailed results of the Mann Whitney tests can be viewed below in Table 3.

Table 3. Summary of student perceptions of engineering technology industry-related skills

	Before Participation		After Participation			Mann Whitney
Understanding of…	Median	Mean Rank	Median	Mean Rank	Z-Score	p-value
Q9. OSHA safety workplaces	3	29.82	4.5	51.18	-4.104	0.00001
Q10. Personal Protective Equipment Use	4	30.72	5	50.28	-3.75759	0.00016
Q11. Common Workplace Safety and Health Hazards	4	29.85	5	50.41	-3.97625	0.00006
Q12. Maintainance of Walking and Working Surfaces	3	30.15	5	50.1	-3.85858	0.00012
Q13. Identifying and Resolving Fall Hazards	3	29.39	4.5	51.61	-4.27239	< 0.00001
Q14. Identifying and Resolving Fire Hazards	3	29.79	4	50.47	-4.00077	< 0.00001
Q15. Emergency Action Plans	3	29.28	4	51.72	-4.31569	< 0.00001
Q16. Preventing Workplace Violence	3	28.26	5	52.74	-4.7054	< 0.00001

Knowledge of College/Industry Success Skills

To parallel the industry skills, students were also asked to rate their understanding of various college and industry success skills. These skills ranged from more learning focused skills such identifying learning styles and strategies for effective studying to life skills such as managing stress and managing money. As with the industry skills, Mann Whitney U Tests were utilized to examined pre/post differences in students' perceptions of understanding. Across the seven areas that were measured, students rated their understanding significantly higher after the conclusion of the bridge program. The smallest increase in student understanding pertained to students understanding of different learning styles, where both groups had a median score of 4. The detailed results of the Mann Whitney U tests can be seen in Table 4.

Table 4. Summary of student perceptions of college/industry success skills

	Before Participation		After Participation			Mann Whitney
Understanding of…	Median	Mean Rank	Median	Mean Rank	Z-Score	p-value
Q17. Different Types of Learning Styles	4	29.97	4	45.82	3.14207	0.00168
Q18. Identifying my Own Learning Styles	3	32.76	4	46.24	-2.62326	0.0088
Q19. Strategies for Managing College Work	3	29.32	4	49.68	-3.96238	0.00008
Q20. Strategies for Effective Studying	3	30.18	4	48.82	-3.6276	0.00028
Q21. Money Management	3	30.17	4	48.83	-3.63259	0.00028
Q22. Effective Communication Strategies	3	30.28	4	47.95	-3.45907	0.00054
Q23. Strategies to Manage Anxiety and Stress	3.5	30.74	5	48.26	-3.40774	0.00064

Recruitment

To examine how to improve recruitment for future bridge programs, students were asked a series of questions about their experiences with the bridge program using short answer responses. This data was coded via inductive thematic analysis, examples of which are depicted in Table 5. Each participant response could be coded multiple times, as the responses were often multifaceted in nature. The most mentioned theme was the industry tours of Micron and STACK Infrastructure by 14 students. The two other frequent codes were students enjoying the hands-on activities from the first week and building connections and making friends.

Table 5. Summary of thematic coding for student favorite part of program

Thematic Code	Sample Codes	Frequency of Codes
CODING	- "I enjoyed the coding the most"	3
COMMUNITY BUILDING	- "I really enjoyed building connections" - "I enjoyed that I got to make friends and interact with other people"	9
HANDS ON LEARNING	- "I enjoyed that it had interactive sections of the course" - "I loved the hands on pneumatics"	10
INDUSTRY TOURS	- "I enjoyed the trip to STACK infrastructure data center. I learned a great deal about why data centers are important" - "The tours at micron and STACK, and learning about data centers"	14
Total		32

Discussion

Overall, the results suggest that students' perceptions of the engineering technology field, data center operations, and industry-related skills, and college success skills all increased due in part to the bridge program. Results indicated that nearly 1 in 3 students found the hands-on learning component of the program to be their favorite part of the program. At Texas State University, the hands-on component of engineering technology is what drew students to the Engineering Technology program over the more theoretical Engineering programs, while still allowing them to pursue a STEM career [19]. Additionally, while there is little empirical research on the benefit of bridge programs for students, research [20] has found that one of the major benefits to be community development. Our study similarly found that students placed heavy importance on building connections throughout their bridge program experience.

This study is not without limitations, the most prominent of which is social desirability bias. Additionally, by only conducting one survey after the conclusion of the program, we run the risk of the participants misremembering their level of understanding of industry and college success skills prior to the bridge program. As the focus of the bridge program was focused solely on engineering technology and data centers, making generalizations about the study difficult. However, this study does shed insight on the impact a non-remedial bridge program can have on student perceptions of an emerging field.

Conclusions

The DCO summer bridge program was largely a success, as a vast majority of students felt more equipped with industry- and college-related success skills. Students found the industry tours, the hands-on experiences, and the community building to be the most meaningful part of the program, which we aim to iterate upon in future iterations of the bridge program. Additionally, after the conclusion of the program, students could differentiate the engineering and engineering technology fields. The more nuanced understanding of the engineering technology field and career opportunities in data center operations brought awareness to a group of individuals who best fit to help solve the upcoming workforce shortage in the data center operations center. Additionally, understanding the differences between the two fields will better equip them to make informed decisions when deciding on their first post-secondary career degree.

Resources

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