Professional Learning Externship as a Strategy to Increase Educator Understanding of Emerging Technological Fields

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Abstract: Markets with emerging technologies face a challenge in finding employees with the knowledge base and skills necessary to fulfill their workforce needs. Generating awareness of these career fields is essential to meet workforce needs now and into the future. This paper discusses the extent to which educator awareness of the engineering technology (ET) and data center operations (DCO) programs and careers change as a result of participation in a professional learning (PL) externship program. Secondary educators in the PL program learned specifics of Northern Virginia Community College's (NOVA) ET programs, toured an ET facility and data center, and developed a plan to disseminate the ET credentialing and career information to their colleagues, students, and parents. In post-participation surveys, educators indicated increased awareness of and interest in ET education programs and career pathways. Additionally, educators indicated an understanding of the industry's need for ET talent and the skills and technical knowledge students need for ET careers. The data supports an educator externship as a PL mechanism for post-secondary institutions to increase awareness of the educational pathways and careers in emerging technologies.

Keywords: outreach, professional learning, educator externship, engineering technology, semiconductor, data center operations, emerging technologies, industry site visits

Introduction

In 2022, the American Semiconductor Academy and SEMI identified the semiconductor industry's key challenge: invisibility to most students and the public. Similarly, the National Institute of Standards and Technology reported a need to "enhance the image and visibility of the semiconductor industry" [1], and the National Semiconductor Economic Roadmap developed an initiative for "driving parent and youth awareness of semiconductor work as a career choice by developing fun and accessible programming" [2]. Delivering on the Promise of CHIPS and Science: Community Colleges and the Semiconductor Workforce calls for officials to "Invest in nationwide programs or in community colleges that are promoting visibility of the semiconductor industry to students and the public" [3]. The abundant growth of the data center industry across the US is also increasing the demand for technicians who require similar knowledge, skills, and abilities as technicians for the semiconductor industry, thus stressing the ET workforce pipeline further. Data Center labor income grew nationally from $43B to $75B from 2017 to 2021 [4], a 74% increase and almost three times the growth across all US industries for the same period. These reports, taken together, suggest meeting the technical engineering needs of employers requires an investment in the community to broaden and diversify the STEM pipeline while educating parents and educators about high-tech manufacturing and technician careers.

High school students gather knowledge about careers through many sources, including parents, teachers, counselors, and peers. Counselors, in particular, have an outsized role in providing students with targeted recommendations for post-secondary education, often advising students directly towards considering (or rejecting) certain disciplines or institutions. Despite their role in directing students towards STEM disciplines, calls for improving career pathways typically focus on professional learning (PL) for in-service teachers [5]. Extant PL programs for counselors tend to address social-emotional and crisis counseling rather than targeted

career development; moreover, these programs are uncommon and limited in scope and duration [6]. Given the role of counselors in the student-career information ecosystem, counselor-focused interventions to help solve information awareness gaps for in-demand fields are warranted.

This paper discusses the structure and design of an educator externship and the extent to which it improved educator awareness of ET and DCO educational programs and careers. The PL was structured for CTE personnel and high school counselors to raise awareness for these relatively invisible ET educational and career pathways in the region. Participants received a programmatic overview of ET and DCO credentials and facilities, toured a local ET manufacturer and a data center, and submitted a plan of how they wanted to apply their newfound knowledge to their practice. The data support the effectiveness of the PL program in increasing educator awareness of emerging technologies and highlight the importance of such programs in supporting post-secondary institutional efforts to meet industry workforce demands.

Program Context & Structure

In Northern Virginia, the semiconductor and data center industries are growing and generating high demand for a skilled ET workforce. Micron started a $3 billion upgrade of their Northern Virginia facility in 2018, which estimated 1,100 new jobs by 2030 [7], and now employee retention is a concern as new facilities open across the US. Northern Virginia is also the largest data center market in the world, and Virginia data center employment increased from 65,500 jobs in 2017 to 86,290 in 2021, a 32% increase [4]. CBRE's 2023 H1 report [8] indicates the data center market increased by 12% during the first half of 2023 and 19.2% year-over-year. Not surprisingly, the DC Metropolitan Area is home to the third highest concentration of technology workers in the country [9], but that talent largely works within Information Technology (IT), not ET.

NOVA's Expanding Regional Capacity for Training in ET and Data Center Operations project, herein referred to as *DCO Tech*, attempts to ameliorate the ET workforce talent shortage by improving the visibility and awareness of ET career pathways in the region through a two-pronged outreach approach: a Summer Bridge Program for high school students and an Educator Externship for career and technical education (CTE) educators and counselors. At the onset of DCO Tech, the project's external evaluator conducted interviews to better understand stakeholder awareness of ET career pathways, roles in fostering and supporting the ET pathways, and ideas for improving ET pathways. The interview findings indicated there was a lack of awareness of these career pathways due to misconceptions of modern manufacturing and competing demands for students' attention [10]. Recommendations from these findings included providing career exploration opportunities and communicating information about skillsets, pathways to employment, and benefits of the careers to students, parents, and educators as strategies to improve K-12 student awareness. Project evaluation surveys of K-12 educators echo these sentiments, suggesting little student or educator knowledge of data center career pathways [11].

The IET marketing team updated the NOVA website and developed an IET marketing folder with academic program flyers for six pathways, a poster, and flyers for the bridge and educator externship programs. NOVA's STEM program coordinators delivered two folders and posters directly to all 70 high school counseling offices in the service area during the winters of 2022 and 2023. When possible, NOVA staff met with school administrators, educators, school and career counselors, and advisors to discuss the NOVA IET programs and recruit participants for the externship program. This was an essential programmatic step that produced high interest in the educator externship. The marketing plan produced 27 applicants from targeted recruitment of CTE educators and counselors to the externship program in Year 1, with (75%) completing the program. In Year 2, 25 educators applied to the program and were accepted, 16 (64%) completed the program.

Educator Externship Program Design

Best practices for educator PL programs require preparation, reflection during and after the program, and completion of a product [12]. The educator externship was designed to provide a short PL opportunity for educators and counselors to learn more about ET and DCO programs and careers. The secondary educator externship consisted of four required components: two industry site tours, a tour of NOVA's ET labs and program overview, and a submitted plan of action. Those completing all components of the program received a $500 stipend. In Year 2, a Program Introduction meeting was added to the schedule to provide a formal introduction to NOVA's programs ahead of the industry site tours. Table 1 provides an overview of the externship.

Table 1: Secondary Educator Externship Program Components

Component	Description
Programs Introduction Meeting Virtual (added in 2023)	Virtual meeting providing an overview of the NOVA ET and DCO pathways, where to find program course information, career insight information, and externship requirements
Engineering Technology Industry Tour In-person	• Tour of advanced chip manufacturer Micron Technology or Lockheed Martin's Manassas Site • Q&A with current employees, industry recruiters, and community outreach coordinators
Data Center Tour In-person	• Tour one of five data center partner facilities (CoreSite, Equinix, STACK Infrastructure, Iron Mountain, QTS Data Centers) • Q&A with current employees, industry recruiters, and community outreach coordinators
NOVA Fab Lab Tour In-person	• Tour of the NOVA Fab Lab, makerspace, and engineering technology classrooms • Review of the ET and DCO programs; discussion of how to improve student recruitment
Plan of Action Asynchronous	Participants create a plan explaining what they learned from the externship, how they will disseminate their knowledge at their school/organization, and how NOVA can assist them with their plans.

Tours were conducted from April through May, and the final session in July was held at the NOVA Fab Lab, a 10,000 square foot digital fabrication lab on the Manassas campus built in partnership with industry partners like Micron Technology to support the engineering technology programs. Plans of action were due by mid-August, ahead of the new school year. The 2023 program included a kick-off meeting in March.

Methods

Participants

In total, 34 educators completed the 2022 and 2023 externship programs. Participants came from five of the eight school districts within NOVA's service region, including predominantly high school college/career counselors and advisors. Educators were given the option to opt in or out of the program's external evaluation study during the application process. Overall, 25 educators (74%) opted to participate in the evaluation study.

Data Collection

Following the completion of the professional development day at the NOVA Fab Lab and the conclusion of the program, participants submitted Plans of Action to articulate how they would implement what they learned during the externship. The externship participants who opted into the program's evaluation study were then sent a survey upon completion of the program.

Educator Externship Plans of Action

Educators' plans of action included three prompts worded as questions: a) what they learned through participating in the externship; b) what actions they will take to share the information they learned, and c) how NOVA and industry partners can connect with them to improve student/teacher/counselor understanding of the ET and DCO pathways and careers.

Educator Externship Survey

The externship survey was designed as part of the external evaluation of the DCO Tech project. The purpose of the survey was to understand participants' perceptions of the program and examine its intended outcomes. The survey included a combination of Likert-scale questions and open-ended questions. The measures addressed in this paper include participants' perceived a) awareness of engineering technology and data center education programs and career opportunities, b) understanding the importance of different skillsets for these careers, and c) confidence in advising students about these careers. The survey was designed as a retrospective pre-posttest, in which respondents provide their "pre" and "post" ratings at the same time (in this case, after participating in the program). Previous research has validated retrospective pre-posttest designs and highlights them as an opportunity to address response shift bias for educational programs [13, 14]. Of the 2022 cohort, 16 of the 18 (89%) opted into the study and provided complete responses to the survey. Of the 2023 cohort, nine of the 16 (56%) opted into the study and provided complete responses to the survey.

Data Analysis

Educator Externship Plans of Action

The program team analyzed qualitative data from all of the submitted plans of action using a thematic analysis approach incorporating both deductive and inductive coding processes [15]. An initial round of deductive coding was performed using structural codes aligned to the plan of action open questions. The program team then conducted a second round of inductive coding to complement and extend the initial round of coding.

Educator Externship Survey

First, the 2022 and 2023 externship survey responses were combined. Then, means and standard deviations were calculated for the retrospective pre-post survey items and the raw mean differences between the pre and post ratings were calculated.

Results and Discussion

Plan of Action: Four themes were identified from the Plans of Action: Industry and Institutional Knowledge Learned, Dissemination and Implementation Plans, Challenges to Generating Student Interest, and Desire for Collaboration with NOVA. See Table 2 for the four themes and the top three corresponding codes and quotes for each.

Table 2: Externship Participant Plan of Action Form Themes and Quotes (Combined 2022 and 2023, n=34)

Industry and Institutional Knowledge Learned	
Industry need for talent (n = 27, 79%)	"Careers in technology and data operations are exploding in this area, and there's a great need to ensure students are aware of said opportunities."
Technical/operational details (n = 17, 50%)	"I like that it doesn't just have to be people in the engineering field, but also can be those interested in the business side of things."
NOVA programs & credentials (n = 17, 50%)	"The hands-on training opportunities that are incorporated into the different degree programs offered at NOVA allows students interested in this field with the opportunity to complete requirements in a short amount of time."
Dissemination and Implementation Plans	
Sharing with colleagues (n = 26, 76%)	"Work with all CTE teachers to help identify students who are interested and skilled in moving forward in the tech field but may not be interested or able to attend 4 year college."
Direct student discussion (n = 22, 65%)	"I will embed information about these programs into post-secondary planning lessons."
Parental engagement (n = 16, 47%)	"The first action is to inform parents of the opportunities and how the electives and general education classes help facilitate the educational pathways to be successful and acquire these types of jobs."

Challenges to Generating Student Interest	
Academic/Administrative (n = 9, 26%)	"I'm extremely excited to share your opportunities with our students and staff, but educators have so much thrown at them it's easy for things to fall off their radar."
External (n = 8, 24%)	"There are many students and families that believe a 4 year degree is the only way to pursue their career, and that certainly is not the case."
Industry working conditions (n = 5, 15%)	"…work hours and schedules that do not mirror the average 9 to 5 may be a deterrent for many young adults who have never had experiences with 10 hour shifts and working on holidays."
Desire for Collaboration with NOVA	
Dedicated NOVA staff member (n = 28, 82%)	"Seek staffing support from NOVA for one NOVA employee to support questions, presentations, information, outreach, etc. within the division."
Presentations from NOVA staff (n = 21, 62%)	"Would like to coordinate a NOVA visit specifically for our SPED/CTE students and host a Lunch and Learns."
Field trips (n=19, 56%)	"Continue providing student tours since it would give them a hands-on opportunity to visualize themselves in the program."

Note: Quotes used are from separate individuals

Educator Externship Survey Results

Responses to the Externship survey are summarized in Table 3. Participant responses indicated they had a higher awareness of engineering technology and data center education programs and career opportunities after the externship program relative to before, particularly regarding their awareness of NOVA DCO programs. Participant responses also indicated they had increased understanding of the importance of different skillsets for DCO and ET careers after the externship program relative to before, particularly regarding the importance of mechanical skills. Finally, participant responses indicated they had increased confidence in advising students about ET and DCO careers after the externship program relative to before, particularly regarding providing secondary students with resources on ET or DCO career pathways.

Table 3: Combined 2022 and 2023 Externship Program Survey Results (n=25)

	Before		**After**		
Awareness of the following opportunities:	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**
NOVA ET Educational Programs	2.36	1.15	4.44	1.16	2.08
ET Careers in Northern VA	2.52	1.30	4.32	1.25	1.80
NOVA DCO Educational Programs	2.08	1.15	4.44	1.19	2.36
DCO Careers in Northern VA	2.40	1.29	4.44	1.19	2.04
Importance of the following skills for ET careers:	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**
Technical Aptitude	3.79	0.88	4.46	0.93	0.67
Communication, Collaboration, and Teamwork Skills	4.04	1.08	4.91	0.28	0.87
Dependability and Reliability	4.08	0.97	4.96	0.20	0.88
Mathematics	3.86	1.03	4.04	1.23	0.18
Technology Skills (e.g., programming, data analytics, cloud computing)	3.71	1.08	4.13	1.19	0.42
Mechanical Skills (e.g., engineering, hands-on troubleshooting)	3.83	0.92	4.75	0.53	0.92
Confidence in the following:	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**
Advising secondary students on the types of classes they should take in high school to prepare for an Engineering Technology degree.	3.13	1.3	4.42	0.78	1.29
Advising secondary students on how to obtain an Engineering Technology or Data Center Operations degree or certification.	2.71	1.46	4.54	0.59	1.83
Providing secondary students with resources on Engineering Technology or Data Center Operations career pathways.	2.79	1.25	4.67	0.57	1.88
Educating my colleagues on guiding secondary students towards Engineering Technology or Data Center Operations careers.	2.83	1.30	4.61	0.58	1.78

Note: SD=Standard Deviation. Scale: 1=Not at all; 2=Slightly; 3=Somewhat; 4=Moderately; 5=Very

Discussion

The results presented above suggest that participation in the externship improved educator awareness of ET and DCO educational programs and careers. The educator externship survey and plan of action analysis both suggest that the externship improved educator awareness for these career pathways and for NOVA's academic programs. Educators in the externship program showed the largest improvement in their self-reported awareness of NOVA's DCO and ET educational programs and careers. While the marketing effort for these programs and pathways was successful in recruiting educators, the surveys revealed that word of mouth marketing is likely since 81% of educators plan to share their new knowledge with a colleague. Externship participants also indicated a need for more collaboration between NOVA, industry, and secondary schools.

Educators' plans of action frequently demonstrated a burgeoning knowledge about the industries and technologies that were discussed during the externship. Plans emphasized some of the key skills and competencies mentioned during tours, such as manual dexterity, high reliability, and a mission-critical mindset. Participants also highlighted some industrial systems common to data centers and semiconductor fabrication, such as power delivery, cooling systems, and programmable logic controllers. Educators contrasted the requirements for these technician careers with 4-year engineering degrees – for example, one participant noted that with "…only two semesters of college education and certification, entry level jobs [at Micron] are high paying" (Participant #17). Another suggested that many students would find these pathways appealing, given that "less math [is] required for those students who don't excel in math, or simply don't want to take the level required for a BS in Engineering" (Participant #20). Throughout plans, the high salaries for these technician roles were consistently brought up as a key selling point for students and parents; as one participant argued, "the starting salaries in these fields stood out to me…for students who may otherwise be hesitant to participate in a 2-year or a certificate program" (Participant #13). These statements offer a view of how counselors are likely to present technician career options to students and demonstrate their expectations of a bias towards 4-year bachelor's degrees.

Educators showed an increase in their self-reported confidence in advising students of ET resources and educational preparation for ET careers. Externship participants planned multiple avenues of disseminating what they learned during the industry site tours and NOVA's ET and DCO program presentations. Broadly, participants' plans for disseminating what they learned were sharing information directly with colleagues, individual student counseling sessions, and direct parent engagement. Most common was the plan to share with colleagues – participants suggested bringing their new knowledge to classroom teachers in relevant disciplines (e.g., CTE, Engineering), presenting it in internal meetings, and adding content to school newsletters. Participant plans for direct student engagement highlighted the need for early intervention. As one participant put it, "it would be beneficial to introduce these early on in high school, when many students have not yet chosen a career path" (Participant #13). Other participants discussed plans to introduce 2-year pathways to students as an alternative pathway, implying that discussions about post-secondary education plans typically center around 4-year degrees.

Nearly all educators felt it would be important to collaborate with NOVA and industry representatives. This collaboration could be working with a staff member for classroom presentations, career nights and speaking with parents, or coordinating field trips to NOVA or an industry partner. Participants emphasized that these techniques could "get students excited about careers in these fields" (Participant #13), allow "students to learn first-hand from professionals" (Participant #33), and "get buy-in from students and parents" (Participant #9). Field trips – either to NOVA's campuses or to industrial sites – were brought up as the most engaging option to spark interest in students. Participant 18 argued that "students will gain a wealth of knowledge by coming and touring the NOVA Fab Lab and learning more about the campus, degrees, programs, and jobs available upon graduation." Most commonly, however, was the suggestion to hire or identify a NOVA staff member to act as a liaison to schools. While many of the strategies recommended by participants are common to outreach programs, participants did not believe their own institutions would be able to offer students technical or experiential learning in emerging technological fields. In other words, while established technical disciplines such as computer science are well integrated into the high school setting, participants in this externship believed that further student engagement in ET or DCO would require outside assistance.

Despite the positive experience of participating in the program, educators raised concerns about the lack of time to fully devote to sharing the information learned. Educators also described the 24x7 career and work-life balance as possible barriers to student interest. There was general agreement that a hands-on approach and in-person experiences would have the greatest impact on drawing students into these career paths. Also of note was the level of participation of college and career counselors compared to CTE educators, whom the project coordinators thought would be the largest participant group when the project was proposed. While college and career counselors can reach a wider student audience, CTE educators working directly with students in the classroom can connect CTE concepts to real-world applications and can more easily identify those students whose aptitude make them ideal candidates for ET careers.

While NOVA chose an educator externship to provide PL to CTE educators and counselors to improve awareness for ET and DCO industries, there are many educational solutions that could be chosen to improve awareness for an industry, such as traditional summer bridge programs for students, extended work-based learning programs, camps, social media campaigns, and face-to-face interactions found at STEM expos, fairs, and conferences [16]. NOVA chose both a student-focused experience for an immediate impact on student recruitment and the educator PL as a long-term strategy to improve awareness and, ultimately, student enrollment.

One challenge to this outreach approach that was not considered during the design process and should be considered by any post-secondary institutions wishing to design similar outreach programs, is the involvement of parents in facilitating the discussion of the types of high wage, in-demand careers available to their children through low-cost educational training options found at community colleges like NOVA. Tackling parent expectations and the myths of 2-year colleges are challenges that community colleges commonly face and could limit the effectiveness of outreach programs to increase student enrollment. As stated by one of the participating high school career counselors: "I would like to set up a parent informational night about NOVA's Engineering Technology Program. I think the parents would benefit from learning about other options than the four-year pathway for their children" (Participant #19).

Conclusion

Markets with emerging technologies need a workforce educated in those technologies. Meeting high-tech manufacturing and technician workforce demands requires investment by post-secondary institutions and industry to broaden and diversify the STEM pipeline through educator, parent, and student outreach programs. The data presented here suggest that NOVA increased educator awareness of ET and DCO careers and NOVA's credentialling pathways to these in-demand, high wage careers through an educator externship. Key to awareness development for participants was access to industry partners and their facilities and the ability to reach all stakeholders who influence students' career decision-making. Dissemination of ET career pathway information through externship participants and continued collaboration with NOVA for classroom visits and speaking engagements with parents and students are cost-effective and likely critical mechanisms to increase the pipeline of students into the ET workforce in Northern Virginia.

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