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Adding Industry-Based Certification and a Recruiting Partnership to Increase High School Participation in a Workforce Pathways Project

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Abstract

The objective of this paper is to share how an industry-based certification (IBC) and a strategic recruiting partnership were integrated with a federally-funded, Arduino-based high school dual enrollment course in basic electricity and instrumentation in order to increase high school teacher participation in the project (see Figure 1). Project COMPLETE is a collaboration between Louisiana Delta Community College (LDCC) and Louisiana Tech University (LA Tech), with pilot partner Bossier Parish School for Technology & Innovative Learning (BPSTIL), to expand instrumentation workforce pathways for high school students in Louisiana. This material is based upon work supported by the National Science Foundation's Advanced Technological Education Program under Grant No. 1801177. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

This paper presents a detailed account of the course mapping process; a final table of learning objectives that meet LDCC dual enrollment and the NCCER Electrical Level I Helper IBC requirements; and a description of a virtual, "flipped classroom" model professional development workshop held jointly with the Louisiana Ag Teachers Association (LATA).

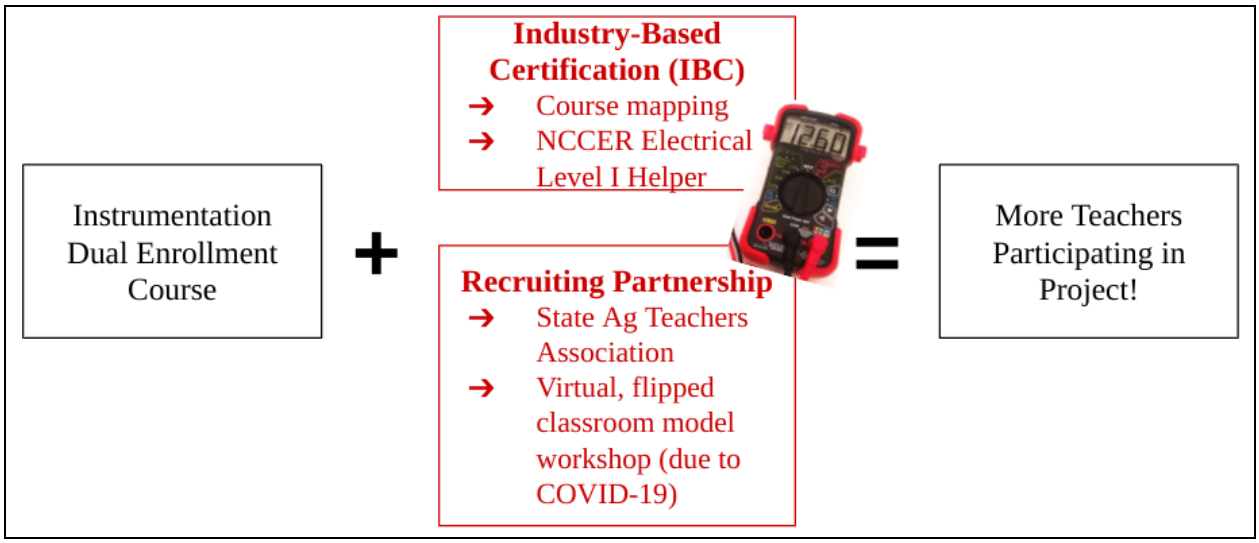

Figure 1: Overview of project additions.

The paper is specifically relevant to two-year colleges who are leading or who want to pursue a federally-funded project involving high school partners, dual enrollment programs, and/or curricula around Arduino microcontrollers. The paper presents specific recruiting and marketing

barriers that were overcome in order to connect an innovative, hands-on curriculum with more high school partners.

The outcomes of these efforts were assessed by an external evaluator, AROS Consulting, through data gathered from project documentation, participant surveys, and stakeholder interviews. Results show that the project exceeded its goal for educator participation, received positive feedback from both teachers and students, and drew helpful recommendations for future improvement. There is still work to be done to extend the project's reach to students themselves, especially in the current pandemic environment.

Introduction

Over the last decade, technological advances such as automation have introduced shifts in the global workforce; this has only accelerated with the recent COVID-19 pandemic. According to the World Economic Forum's 2020 Future of Jobs Report, "by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms" [1].

This situation presents a large opportunity, and dire need, for a prepared skilled technical workforce (STW). Project COMPLETE aligns with the National Science Board's recommendations to create more STW opportunities for Americans by a) promoting the message that skilled technical work can lead to many educational and career pathways, and b) addressing local workforce needs through partnerships among a two-year college, university, K-12 schools, and industry partners [2].

To build the STW in Louisiana, Career and Technical Education (CTE) plays an important role in K-12 education. During the 2017-2018 school year, Louisiana had 130,107 secondary CTE participants; and 96% of Louisiana secondary CTE concentrators met performance goals for technical skills [3]. Project COMPLETE supports Louisiana's CTE program by providing learning materials and connections to industry and postsecondary education for students on a variety of CTE pathways.

In rural North Louisiana, where Project COMPLETE is based, employers need "multicrafted" workers with electrical and instrumentation skills (per informal industry survey). For instance, mechanical assembly positions require more wiring skills; and electrician positions require more knowledge about instrumentation and controls. Project COMPLETE works to build the pipeline into these types of positions, especially in North Louisiana's target sector of Advanced Manufacturing [4].

Project Goals

Background: The ultimate long-term goal of Project COMPLETE is to increase high school students' interest in and preparation for career pathways in North Louisiana's instrumentation-related fields. LDCC started toward this goal by building a comprehensive collaborative infrastructure with a research university, seven high schools, and five industry partners in North Louisiana [5]. In parallel, the Curriculum Team created a hands-on, project-based high school curriculum around Arduino microcontrollers [6]. However, a good curriculum "product" would not be impactful without fidelity of implementation at partner high schools.

Current Goals: In order to expand the project's reach, the team's two goals were*:*

a) to increase teacher/counselor participation in Project COMPLETE professional development
b) to increase subsequent implementation in high school classrooms

Please see Figure 2 for past participation levels and current goals for teacher/counselor recruitment.

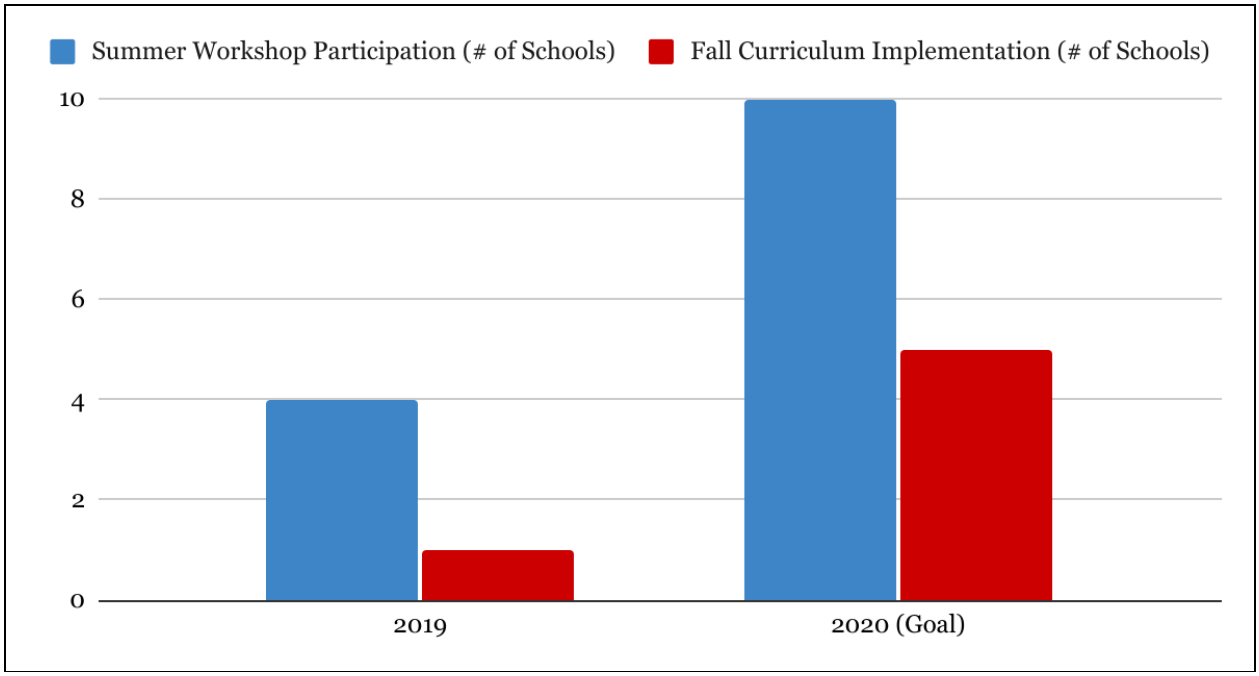

Figure 2: Project participation and implementation goals.

Partners

Project COMPLETE is a collaboration between Louisiana Delta Community College (LDCC) and Louisiana Tech University (LA Tech), with pilot partner Bossier Parish School for Technology & Innovative Learning (BPSTIL). As will be discussed below, the team also developed a partnership with the Louisiana Ag Teachers Association (LATA) in order to market the program to more teachers across the state.

LDCC has a strong Industrial Instrumentation Technology program based in Monroe, LA, with a satellite program at its Ruston, LA, campus. Across all campuses, the program has relationships with over 20 local manufacturing companies. Educational facilities include a 4,700 sq-ft instrumentation lab housing trainers valued at over $1.1 million, a majority of which has been supplied by industry partners.

LA Tech is a four-year research university based in Ruston, LA. LA Tech offers a bachelor's degree in Instrumentation & Control Systems Engineering Technology that covers a combination of engineering theory, mathematics, and hands-on applications. LA Tech maintains strong relationships with many area high schools and has developed grant-funded curricula and professional development (NSF Grant #0618288, NASA Grant #NNX09AH81A). Application-focused student experiences have continued to expand over the past ten years through ongoing assessment and evaluation by the Industrial Advisory Boards overseeing LA Tech's ten engineering and engineering technology programs.

BPSTIL is a Career Technical Education (CTE) hub for the Bossier Parish School Board, operating under Louisiana DOE requirements for Jump Start CTE programs. For adoption of new curricula/programs, significant emphasis is placed on (1) career fields with significant potential for full employment and (2) college and career readiness, as measured in part through student completion of Industry Based Certifications (IBCs) and dual-enrollment college credits. BPSTIL's students combine academic skills learned in the classroom with practical experience in shop/lab settings. Many students are also dually enrolled with local community colleges, and the majority of classes available at BPSTIL offer an IBC. Advisory boards from the business community assist in directing curriculum to meet the state and local employment needs.

LATA represents the interests of the agriscience teaching profession in Louisiana. It provides resources for strengthening programs and for enhancing the skills of Louisiana's agriscience teachers. The peer-led organization offers an annual conference, email updates, online resources, and professional development opportunities for high school ag teachers across the state.

Original Dual Enrollment Course

Background: The originally proposed National Science Foundation project was a high school dual enrollment course, focused on basic electricity and instrumentation, that would earn students credit at LDCC and could be transferred to LA Tech in each of the schools'

instrumentation degree programs. The course was created to align with a) the workforce needs outlined in the Introduction section above and b) Louisiana's "Jump Start" program. Louisiana Jump Start is a CTE initiative by the Louisiana Department of Education to better prepare high school students for local high-need, high-wage career paths upon graduation [7]. The program offers incentives for high schools with Jump Start pathways, so it was an important marketing decision to align Project COMPLETE with this program. As such, BPSTIL identified Louisiana Course Code 110600 "Basic Electricity and Electronics," which qualifies as a technical course in many Jump Start pathways. This would be helpful to other high schools interested in the program, but the project team would soon learn that an Industry Based Certification would even better align with state education needs and incentives.

Dual Enrollment Course Mapping: BPSTIL worked with the Project COMPLETE team to build a semester long, double blocked course that would both meet BPSTIL's CTE objectives and the Project COMPLETE program objectives. The result was the integration of the Project COMPLETE curricula with a basic electrical wiring course. BPSTIL's goal was to build a foundational course that would provide a range of electrical technology career options for students.

The Project COMPLETE team started with the existing learning objectives for LDCC dual-enrollment courses INST 1000 (Intro to Industrial Instrumentation) and INST 1010 (Fundamentals of DC and AC Circuits). These basic learning objectives for these courses are shown in Figure 3.

The LDCC learning objectives were then integrated with learning objectives for the corresponding LA Tech ICET course (ENGT 120: Engineering Technology Problem Solving I); see Figure 4. BPSTIL maintained these learning objectives in a multi-level course outline spreadsheet throughout the development and pilot, which also served as the course pacing guide.

Addition of Industry-Based Certification

For the general electrical wiring (electrician's apprentice) coursework, BPSTIL worked with representatives from the National Center for Construction Education & Research (NCCER), the Electrical Training Alliance (etA)/International Brotherhood of Electrical Workers (IBEW), and the state DOE. The NCCER Electrical Level 1 curricula was selected to pilot the program. Specifically, the goal was to complete training modules from the NCCER program that would allow students to complete the NCCER Electrician's Helper IBC. Figure 5 outlines the Units that makeup the Project COMPLETE course along with the 12 Modules required to complete NCCER Electrical Level 1. The shaded Units/Modules represent areas of significant overlap in the curricula. The NCCER Electricians Helper IBC modules are also highlighted with an asterisk.

	INST 1010 Learning Objectives
1	Identify the term schematic diagram and identify components in a circuit from a simple schematic diagram.
2	State the equation for Ohm's Law and describe the effects on current caused by changes in circuit
3	Given simple graphs of current versus power and voltage versus power, determine the value of circuit power for a given current and voltage.
4	Identify the term power, and state three formulas for computing power.
5	Compute circuit and component power in series, parallel, and combination circuits.
6	Compute the efficiency of an electrical device.
7	Solve for unknown quantities of resistance, current and voltage in a series circuit
8	Describe how voltage polarities are assigned to the voltage drops across resistors when Kirchhoff's voltage law is used.
9	State the voltage at the reference point in a circuit
10	Define open an short circuits and describe their effects on a circuit.
11	State the meaning of the term source resistance and describe its effect on a circuit.
12	Describe in terms of circuit values the circuit condition needed for maximum power transfer.
13	Compute efficiency of power transfer in a circuit.
	INST 1000 Learning Objectives
1	Define process instrumentation and explain its relation to other disciplines.
2	Identify important present day trends in the instrumentation field.
3	Identify sources of training for instrumentation professionals.
4	Define process control and identify the kinds of variables found in process control.
5	Identify the control elements of a process control system and explain their functions.
6	Compare static and dynamic performance characteristics of a control system.
7	Define a control loop, and identify the types of control loops.
8	Define a control strategy and compare the common types of control strategies.

Figure 3: Dual enrollment course learning objectives.

[redacted] Instrumentation Technology Program *INST 1000 and INST 1010*	[redacted] Instrumentation and Control Systems Engineering Technology *Essential Topics of ENGT 120*
INST 1000	***ENGT 120***
Present-day trends in instrumentation	Global and Societal Current Issues / Resource Awareness / Professional Organizations
Process instrumentation and its relation to other fields	
Sources for training for instrumentation professionals	
Industry and standards organizations	
Piping and instrumentation diagrams	
Control elements and their functions	Implementing control loops and strategies in an Arduino microcontroller with a wide variety of sensors.
Process control & variables associated with it	
Static and dynamic control system performance characteristics	
Types of control loops	
Types of control strategies	
	Using spreadsheets for curve fitting to calibrate sensors
	Measuring and characterizing an energy conversion system (a centrifugal pump)
	Using solids modeling software to design parts
INST 1010	Using Kirchoff's Laws to analyze circuits
Symbols, components and schematics of DC and AC circuits	Symbols, components and schematics of DC circuits
Units of measurement and characteristics associated with resistors, capacitors, and inductors	Electrical units of measurement, and their relationships to circuit components
Measuring and troubleshooting circuit problems with test equipment	Measuring and troubleshooting circuit problems with multimeters
Series and parallel DC and AC circuits	Series and parallel circuits
Using Ohm's Law to analyze circuits	Using Ohm's Law to analyze circuits
Voltage divider circuits	Voltage divider circuits
Bridge Circuits	

Figure 4: Mapping of course topics between community college and university.

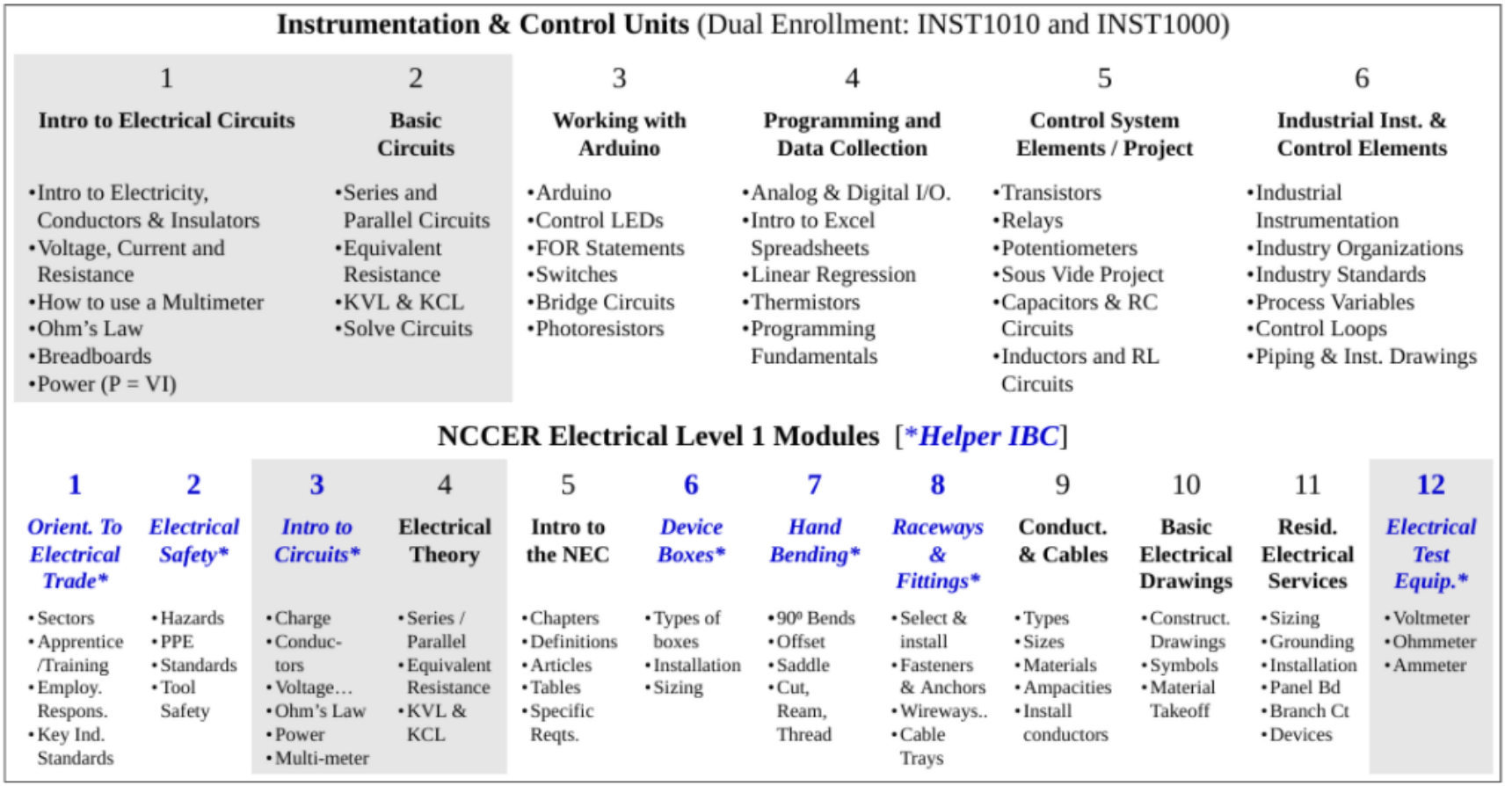

Figure 5: Integration of dual enrollment material with IBC content.

The areas of significant overlap between the NCCER Electrical and Project COMPLETE curricula are in basic electrical circuits, electrical theory, and electrical test equipment. BPSTIL used this overlap to both enhance training in these areas and reduce the total number of instructional hours needed to complete both the dual-enrollment Project COMPLETE course and the Electrician's Helper NCCER IBC. The NCCER Orientation to the Electrical Trade and Electrical Safety modules were taught first to establish basic expectations for professionalism and safety. The full dual-enrollment Project COMPLETE course (Units 1 through 6) was then completed through the final exam, to ensure that students seeking dual-enrollment credit would have time to fully complete the requirements for college credit. Finally, the remaining NCCER Electrician's Helper IBC Modules were completed as time permitted. A second semester of NCCER/etA electrician's training is also being piloted to allow students pursuing an electrician career pathway to earn additional IBCs, and more fully prepare for an apprenticeship program.

Recruiting Partnership and Virtual Workshop

In addition to integrating an IBC into the Project COMPLETE curriculum as an option to interest high school partners, the team was also searching for a way to multiply physical reach among potential partners. Around this time, one of the project's high school teachers invited participation with an organization of which he was a member, the Louisiana Ag Teachers Association. This was a timely opportunity to connect with teachers who could be very interested in Project COMPLETE content, as they likely already taught basic electricity concepts!

The partnership conversation began in late spring 2020. Early in Summer 2020, the Project COMPLETE team made the decision to incorporate its summer workshop with the annual LATA conference which was to be held on July 22, 2020. However, just over a week before the conference, the LATA President informed the team that the in-person conference was cancelled in keeping with the Governor's announcement on gathering restrictions due to COVID-19. It was decided the event would be online.

The team quickly adapted to a virtual, "flipped classroom" model professional development workshop held jointly with LATA. Project COMPLETE staff coordinated an online registration form, Zoom logistics, speaking topics, professional development videos, and stipend payments; while LATA's President provided input to workshop planning and communicated details to LATA members.

A total of eleven videos were created for participants to watch in preparation for the workshop. The videos were optional, and participants were provided a small stipend for each video watched before or after the workshop itself. This video-based professional development allowed for flexibility, which was especially important during a pandemic where teachers were home with competing work and family responsibilities. The video model has also been beneficial for the project in two ways. First, a larger, more diverse group of speakers were involved than are usually available for in-person workshops. Second, the videos are now public on the project's

website [8], available to be played by multiple audiences, including new or potential teacher/counselor partners, high school students, and parents.

The videos include:

- Project COMPLETE Summer 2020 Professional Development Overview
- Project COMPLETE Hosts an Industry Panel
- Recruiting and Supporting Underrepresented Students in Project COMPLETE
- What is Industrial Instrumentation?
- Walking Through Your Kit
- Intro to the Arduino
- Project COMPLETE Shares a Sous Vide Intro
- Project COMPLETE and an IBC! (Industry-Based Certification)
- Project COMPLETE from a CTE Perspective (Career and Technical Education)
- Project COMPLETE Talks Instrumentation at LDCC
- Project COMPLETE Talks Instrumentation at LA Tech

For planning the "live" portion of the workshop, the Project COMPLETE team held a meeting through the online meeting software Zoom. Here it was decided to change the workshop's live portion into a virtual format as well. The team chose to narrow its focus of speaking topics to include:

1) An overview of Project COMPLETE
2) Description of the project's "hands-on" electrical kits
3) Discussion on implementing Project COMPLETE in high schools
4) A Q&A session intended to solicit feedback from the teachers and counselors about their specific concerns with teaching the curriculum

It is important to note that speaking responsibilities were divided up among the project's college and high school representatives, which allowed workshop participants to hear about various aspects of the program. For instance, a high school counselor shared about how to enroll students in courses and get them specific credit. Since every school has to navigate their version of curricula, credit, and state education priorities/incentives, this was an important topic to cover. It was also valuable for the workshop's teacher participants to learn what the project's curriculum looks like in the classroom, so a high school teacher led this part of the workshop.

It's no surprise, given the advancement of technology, that the "virtual classroom" is becoming more common. However, the recent COVID-19 pandemic with the associated distancing protocols has increased the demand for virtual teaching/conferencing in a way that exceeds the comfort level of some. In response to this challenge, our Project COMPLETE team members have learned to pool resources and draw from each other's strengths. We live in an unprecedented time which demands cooperation and teamwork.

Recommendations

The Project COMPLETE team has a number of recommendations to share with colleagues at other two-year colleges who are leading grant-funded workforce development projects in partnership with high schools. First, it is imperative to stay on track with the originally proposed goals while taking into consideration unexpected changes like COVID-19. When building partnerships for recruitment or implementation, it is advantageous to connect with other groups in the area that might already exist to share ideas. These contacts can be made through social media outlets as well as word of mouth. Organizational partnerships, compared to individual partnerships, really have the potential to scale work fast.

When looking for a pilot high school partner, it is crucial to find the right teacher. Career and Technical Education (CTE) high schools often hire teachers with industry experience, which the Project COMPLETE team has found to be an extremely valuable component in building this program. The team also recommends looking for retirees who have a passion for sharing their vast knowledge and training. Experience is a great teacher, and often they can share information that just cannot be found in books. For instance, Project COMPLETE has received positive feedback from providing a retired industry speaker as a resource to high school classrooms. Teachers can ask questions, and the industry expert can talk to students and give valuable perspective.

A more broad recommendation, related to program content, is to take into consideration the types of industries in a given area and to choose broad content that opens many opportunities in a career. For example, in the field of manufacturing, an understanding of automation including Programmable Logic Controllers and mechatronics goes a long way. The next step is to reach out and make contact. Generally speaking, there are more technical jobs available than there are people trained to fill them. It is as important to companies in a region to have technicians to fill their jobs as it is for learning institutions to produce them. This dynamic makes a partnership mutually beneficial. By reaching out to these companies, a two-year college can better ensure that the training it is providing will fill employer needs.

Project Evaluation Results

The project's evaluation was performed by an external evaluator, AROS Consulting. The results presented below have been extracted from external evaluation reports provided by AROS and are based on data gathered through project documentation, participant surveys, and stakeholder interviews.

<u>Curriculum completion:</u> The development of the curriculum has incorporated elements and guidance from several sources, including an industry-recognized curriculum, high school, and university instructors, requirements set forth by both LA Tech and LDCC, and industry contacts. The curriculum targets the key automation competencies outlined in the grant

proposal. The curriculum has been developed and finalized following the plan laid forth in the grant proposal, and the Project COMPLETE website hosts the resources for the class, which includes General Curriculum Resources (i.e., planning resources, a pre-test, and curriculum terms) and Curriculum Units 1 through 6 (i.e., lessons, supplemental resources, and tests). The project team intended to begin a lesson-by-lesson curriculum pilot testing in a high school during year one, but moved the pilot testing of the curriculum into year two due to complications with a partner school. The curriculum was successfully pilot tested in the fall of 2019, and has been carried out in part or in full with several Louisiana high schools.

Workshop participation: To provide resources to teachers that instruct or plan to instruct the curriculum, the project team hosted a summer 2020 teacher workshop on July 22, 2020. Thirty teachers, counselors, and administrators from 25 schools attended the virtual workshop. There were 21 teachers and counselors who watched the professional development videos for the summer 2020 workshop and took corresponding quizzes on the videos' content (a total of 186 quizzes were completed).

A second workshop was held on December 5, 2020. Two teachers who have both implemented the Project COMPLETE curriculum attended the workshop. The goal of this workshop was to obtain feedback and discuss the teachers' experiences with the curriculum. This workshop was beneficial for both the teachers and the project team.

The original grant proposal indicated that the project team would hold two dissemination workshops for teachers/counselors from at least ten schools during Year 3. At present, the grant team has exceeded this goal by reaching over 30 educators from 25 schools between the virtual summer workshop, the winter workshop, and the workshop professional development quizzes.

Workshop participant feedback: Survey results from those who attended the workshop were positive. There were 18 responses from workshop attendees (60% response rate). Over 80% of respondents felt that the professional development videos were informative and facilitated their understanding of the workshop's content. Nearly every respondent agreed that all three presentations were a valuable use of time and that the workshop was an appropriate length of time. However, only 61% of respondents agreed that they feel comfortable explaining Project COMPLETE's purpose to colleagues, and 67% agreed that they would advocate for Project COMPLETE at their school. All but one respondent felt that Project COMPLETE's importance to students was clearly communicated at the workshop.

Survey results from the summer workshop suggest that the workshop time is being properly utilized. Open-ended responses consisted of several raving reviews (e.g., "Well put together, worthwhile looking project, and nice to know its available!"). Recommendations from respondents include: shortening some of the videos, adding more teachers that have

implemented the program to the delivery of the workshop, adding a hands-on training component, as well as perspectives from students who have completed the curriculum.

Curriculum implementation: Two high schools successfully carried out the full curriculum in the fall of 2020. BPSTIL's enrollment increased 300% from the pilot semester. Instructors at both schools reported that any difficulties in implementing the curriculum were due to setbacks produced by the COVID-19 pandemic (e.g., students were in and out of the classroom due to infection and quarantine-related absences). Nine high schools reported that they plan to implement the curriculum in the spring semester and/or whenever their district allows them to have students on campus.

The teachers and counselors from both schools that implemented in the fall have submitted feedback. The teacher and administration relayed positive comments about the Project COMPLETE team, specifically in the areas of communicating expectations, availability as a resource, timeliness of support, and diligence. Overall, their recommendations to the team were to continue to refine the curriculum and evaluation procedures, the continuation of recruitment efforts to parents and students, and to other districts to ensure the project is made widely available.

Student feedback: According to a survey used to gauge the fall 2020 curriculum's impact on students (38% response rate), we found that nearly all of the students surveyed were satisfied with the curriculum's content and would recommend the course to other students interested in instrumentation technology. All of the students agreed that the course met their developmental needs and the materials were not too difficult to grasp.

Future recommendations: COVID-19 significantly impacted the extent to which students were exposed to the industry through field trips and other events. If ongoing COVID-19 irregularities ensue, education partners' suggestion is to market directly to parents and provide live online Q&A panel sessions. Also, direct marketing, such as flyers to students, is still needed in schools currently implementing the curriculum.

To encourage current and future participation in workshops and the curriculum, the grant team is offering stipends for education partners for attending workshops, completing video quizzes, and implementing the curriculum. As COVID-19 protocols diminish over the coming year and stipends are presented to partners, we believe that curriculum implementation will continue to expand.

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