AZ RAMP UP

Final Evaluation Report

Arizona Regional Advanced Manufacturing Upgrade Project
TAACCCT Consortium Grant (Round 4)

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MN ASSOCIATES, INC.
WWW.MNASSOCIATESINC.COM

COMPLETED BY:
Kavita Mittapalli, Ph.D.
Nina de las Alas
Amlan Banerjee, Ph.D.

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1.0 Executive Summary

1.1 Description and Activities

In September 2014, the Department of Labor's TAACCCT program awarded a consortium of four Arizona community colleges—Central Arizona College (CAC)[1], Eastern Arizona College (EAC), Estrella Mountain Community College (EMCC) and GateWay Community College-Central City (GWCC)—a Round 4 grant to deliver competency-based training so that TAA-eligible workers and other adult learners will have the skills and credentials they need to secure well-paying positions in the growing advance manufacturing sector. These lucrative jobs can be found throughout urban Maricopa county (Phoenix metropolitan area), and rural Graham, Geenlee, Gila, and Pinal counties—the targeted region for the grant.

To deliver on this bold goal, the AZ RAMP UP project was expected to have established the following by the end of the grant: 1) **stacked and latticed credentials** in CAD/drafting, electronics, industrial maintenance, machining, manufacturing technology, and welding; 2) **seven new, accredited programs** recognized by the industry in the above fields; 3) **13 enhanced, existing programs**; 4) **1,009 unique participants served** through accelerated, competency-based learning model; 5) o**nline contextual remediation**; 6) fully developed **curricula modules**; 7) **faculty trained in competency-based instruction and assessment**; 8) **articulation agreements with four-year institutions** for participants to continue to their education; and 9) **effective student support through proactive advising**.

The AZ RAMP UP project rested its success in meeting the above deliverables by utilizing strategies that were grounded in evidence or well-documented promising practices on **competency based-learning** (National Study of Student Engagement, 2011; Long, 2000; Lovett et al., 2008); **industry-endorsed credentials** (University of Phoenix and National Association of Manufacturers, 2010; ACT, 2013); **prior learning assessment** (Klein-Collins, 2010); **block scheduling** (Indiana Career Council, 2013); **proactive advising** (Schwabel et al., 2012); **online learning and support** (Jaggers, 2011); **Fab Labs** (Ginger et al., 2012); **career awareness and goal-setting** (Swail, 2002); **apprenticeships and internships** (Lewis & James, 2011).

1.2 Evaluation Design Summary

The AZ RAMP UP consortium colleges secured the services of MN Associates, Inc. (MNA) to conduct the external evaluation study of the grant. The study had two components: 1) program implementation study (formative evaluation) and 2) outcomes and impact study summative evaluation). The latter composed of a

[1] Lead institution and fiscal agent

quasi-experimental design using a prior cohort comparison group. Both the implementation and outcomes and impact study components were developed to inform the work of the consortium colleges, their respective community college networks and public school systems, industry and workforce investment partners, and the larger communities of Maricopa, Graham, Geenlee, Gila, and Pinal counties. The evaluation study had three goals: 1) assess the extent to which the career pathways funded by AZ RAMP UP TAACCCT grant improve employment outcomes of participants across the consortium colleges compared with students from traditional certificate and certification programs; 2) understand the project's implementation to inform current and future projects, the scaling of successful programs, and to help interpret project outputs and outcomes; and 3) develop and implement tools and procedures to improve the consortium's institutional capacity to engage in continuous discussions around program improvement.

The evaluation study is aligned with the AZ RAMP UP logic model (see Figure 3 from project narrative). The implementation study examined whether the four core implementation strategies took place. The outcomes and impact data examined whether the outputs were met and outcomes were achieved.

The implementation study design addressed a series of research questions pertaining to the following:

- **curriculum** (e.g., How were the AZ RAMP UP program designs improved or expanded using the grant funds? What delivery methods were offered, and how did participants experience them?)
- **assessment tools and processes** (e.g., What were the challenges in the AZ RAMP UP courses and assessment development per program? Was an in-depth assessment of participants' abilities, skills, and interests conducted to select participants for the grant program?)
- **outreach, recruitment and support** (e.g., What outreach and recruitment strategies were in place? What support services and other services did AZ RAMP UP offer?)
- **partner collaboration** (e.g., What contribution did each of the partners make in terms of: 1) program design, 2) curriculum development, 3) recruitment, 4) training, 5) placement, 6) program management, 7) leveraging of resources and commitment to program sustainability?)

MNA utilized multiple data collection tools and sources to determine how the AZ RAMP UP project was implemented. They included interviews, focus group discussion, project document reviews, surveys, observations and artifacts based on annual site visits to all four consortium colleges. MNA applied qualitative narrative content analysis and quantitative descriptive statistics to parse through the collected data. Capacity building was documented in terms of whether the strategies, activities, or deliverables initially described in AZ RAMP UP's work plan were met.

The outcomes and impact study design addressed a series of research questions pertaining to the following:

- **participant outcomes to date** (e.g., to what extent were participants satisfied with the courses/offerings and their relevance to the job market?)
- **operational strengths of the project and opportunities for improvement** (e.g., What if any challenges emerged in the implementation process? How were the challenges resolved? What were the lessons learned)

AZ RAMP UP project staff collected participant data using Social Solutions©. Data collected that were relevant to the outcomes and impact study included demographic data (e.g., age, gender, race/ethnicity), special status (e.g., veteran, Pell grant-eligible, TAA-eligible), program performance (e.g., credits received, completion), wage data, and career navigator case notes.

MNA attempted to collect comparison group data from CAC, EAC, EMCC, and GWCC, with each consortium college selecting a comparable group to match against the AZ RAMP UP participants enrolled in their respective colleges. However, due to lack of outcome data for the comparison group, MNA adopted a pre- and post-program within group design to measure the project's impact. Participant wages were collected through self-reported surveys. Statistical tests were conducted to measure the significance of the difference between the pre- and post-completion wages.

1.3 Implementation Findings

At the close of the grant period, AZ RAMP UP met nearly all of its commitments. Highlights of the implementation findings include

- **Implementation of AZ RAMP UP experienced a sluggish start with personnel turnover for many positions at the beginning but the project recovered and got back on track at the end of year 2**.
- **AZ RAMP UP successfully enhanced 19 existing programs and launched eight new programs**.
- **CAC, EAC, and EMCC had completed articulation agreements with ASU, NAU, and UA**[2] for its AZ RAMP UP programs by the end of grant period.
- **Prior learning assessment was mostly moot because of the lack of experience from most participants.** Participants who had some prior experience were tested by instructors to perform

[2] ASU = Arizona State University, NAU = Northern Arizona University, UA = University of Arizona

tasks based on industry-endorsed credentialing assessments. Participants who passed the assessments were allowed to advance to the next level.

- **The AZ RAMP UP project has engaged more than industry partners.** Partnership varied by type and degree of collaboration and by college.
- **Career navigators provided varying types of assistance and proactive advising to participants.** Their services included assessment of interest and possible career pathways, program enrollment and financial aid, participant retention, alignment of programs of study with career goals, job readiness and employment processing, and job placement assistance.
- **Participants gave high approval ratings to all aspects of the program they participated in, with the exception of the participants in the "industrial maintenance" programs.** In general, the fee structure received the lowest ratings across all areas of study.
- **While the majority of the participants at CAC, EAC, and EMCC expressed high satisfaction with their programs, the participants at GWCC gave moderate ratings to their programs.** A probable basis for the lowered satisfaction with the programs at GWCC was the turnover of machining instructors and location changes of equipment which occurred in 2016. Since then and after participant survey results were collected, student dissatisfaction with the programs' shortcomings was fully resolved.

1.4 Participant Impact and Outcomes

- **The majority of the participants were white males.** CAC recruited the highest share of black participants (about 11%). About 40% of the participants at CAC and EMCC were of Hispanic origin.
- **Half of the participants were Pell grant eligible at all colleges.** GWCC and EMCC recruited highest percentage (about 30%) of veterans.
- **Based on June 2018 data (see table below) AZ RAMP UP met two of the nine of the target outcomes.**
- **Overall, the length of time to completion shortened as the project matured.** The average time to completion was shortest in GWCC (2.8 months), followed by CAC (5.1 months), EMCC (6.5 months), and EAC (9.7 months).
- **Data show that the majority of the participants across the four consortium colleges completed the requirements to earn a professional credential or were in the process of completion.**
- **Results from the analyses show that non-eligible participants pursued professional certificates in higher proportions, whereas Pell grant-eligible participants pursued associate's degree in higher proportions.**

- In 2016, the latest year for which the wage data is available, the average hourly wage in the manufacturing industry in Arizona was $17.60. **Only EMCC participants were found to be earning higher hourly wage than the state average**. Both EAC and GWCC had sample sizes too small to conduct a statistical test.

Table 1: Actual to Target Comparison (years 1 through 4 as of June/July 2018)

Outcome Table	Year	CAC	EAC	EMCC	GWCC	Total	Target[3]	Status
1: Total unique participants served	**1**	32	58	0	0	90	148	Not met
	2	36	118	172	31	357	434	Not met
	3	76	108	33	55	272	477	Not met
	4	34	107	45	24	210	N/A	N/A
	TOTAL	**178**	**391**	**250**	**110**	**929**	**1009**	**Not met**
2: Total participants completing a TAACCCT-funded program of study	**1**	0	0	0	0	0	0	Met
	2	18	20	12	21	71	282	Not met
	3	27	17	34	40	118	381	Not met
	4	17	8	13	29	67	N/A	Not met
	TOTAL	**62**	**45**	**59**	**90**	**256**	**659**	**Not met**
3: Number of participants still retained in their program of study or other TAACCCT-funded program[4]	**1**	31	58	0	0	89	91	Not met
	2	30	116	156	8	310	259	Met
	3	57	138	109	12	316	316	Met
	4	51	232	139	3	425	N/A	N/A
	TOTAL	**51**	**232**	**139**	**3**	**425**	**681**	**Not met**
4: Total number of participants completing credit hours[11]	**1**	15	0	0	0	15	49	Not met
	2	41	126	128	0	295	121	Met
	3	74	226	145	0	445	129	Met
	4	86	96	134	0	316	N/A	N/A
	TOTAL	**216**	**448**	**407**	**0**	**1071**	**308**	**Met**
5: Total number of participants earning credentials[5]	**1**	0	0	0	0	0	0	Met
	2	11	23	13	31	78	278	Not met
	3	29	20	46	45	140	375	Not met
	4	18	9	13	29	69	N/A	N/A
	TOTAL	**58**	**52**	**72**	**105**	**287**	**654**	**Not met**
6: Total number of participants	**1**	0	0	0	0	0	0	Met
	2	0	1	0	0	8	47	Not met

[3] AZ RAMP UP received a no-cost extension which extended the period of accepting participants to the program through spring 2018.

[4] This number is a running total. Thus there is no overall total.

[5] GWCC participants accrue clock hours and not credit hours.

Outcome Table	Year	CAC	EAC	EMCC	GWCC	Total	Target[3]	Status
enrolled in further education[6]	**3**	0	0	1	0	7	63	Not met
	4	0	4	0	0	6	N/A	N/A
	TOTAL	**0**	**5**	**1**	**0**	**21**	**100**	**Not met**
7: Total number of participants employed after TAACCCT-funded program of study completion	**1**	0	0	0	0	0	0	Met
	2	5	0	2	1	8	115	Not met
	3	4	0	3	0	7	115	Not met
	4	6	0	0	0	6	85	Not met
	Total	**15**	**0**	**5**	**1**	**21**	**315**	**Not met**
8: Total number of participants retained in employment after program of study completion	**1**	0	0	0	0	0	0	Met
	2	3	0	0	0	3	103	Not met
	3	4	0	0	0	4	103	Not met
	4	4	0	0	1	5	77	Not met
	Total	**11**	**0**	**0**	**1**	**12**	**283**	**Not met**
9: Participants employed at enrollment receiving a wage increase post-enrollment	**1**	0	0	0	0	0	0	Met
	2	0	0	0	3	3	72	Not met
	3	30	1	60	11	102	124	Not met
	4	19	0	11	11	41	110	Not met
	Total	**49**	**1**	**71**	**25**	**146**	**306**	**Not met**

Looking back at the both implementation and perceived impact of the AZ RAMP UP project, the project staff shared similar key takeaways or successes. Among the key takeaways/successes were

1) **upgraded state-of-the-art facilities with commensurate revised curriculum and instruction**
2) **greater collaboration across the region**
3) **successful job placement of completers in their trained fields, and**
4) **the presence of career navigators who provided the human touch in the "hi-tech, hi-touch, hi-impact" approach of the AZ RAMP UP project.**

There were many lessons learned over the course of the grant. Specifically,

1) **"Having the right people, at the right place, at the right time" was critical to the success of the grant.**
2) **AZ RAMP UP project staff must be flexible to change.**

[6] Completers who enrolled in further education.

3) **Inertia from institutional bureaucracies was often underestimated.**
4) **Conducting rigorous, comparative evaluation studies required robust data sets that most colleges do not have or faced considerable difficulty to acquire.**
5) **Political and economic conditions will continue to change and affect the trajectory of the AZ RAMP UP programs.**

1.5 Conclusion and Implications

One of the challenges in reporting on the impact of the project was the dearth of wage data available from the participants. Other TAACCCT grants have expressed a similar challenge. One of the next steps for studying approaches and strategies tested under the AZ RAMP UP project is finding innovative approaches to collecting wage data consistently and efficiently across participants and non-participants. More wage data can shed light on which occupations on average earn more and if further education through a bachelor's degree in applied science provides a substantial net gain in wage earnings against deferred income and student debt.

Higher education institutions interested in replicating the AZ RAMP UP project are advised to invest time and effort in the theoretical underpinnings of the proposed project and to devise a well-crafted logic model and work plan based on evidence-based practices. Moreover, institutions should also examine closely their proposed personnel and their ability to see the project through. As shown in this report, the linchpin to the success or hardship of the project rests on the leadership of key personnel on the project.

Federal and state policymakers interested in scaling up the best practices of AZ RAMP UP, should keep in mind how public funding of higher education can help foster economic growth. Through public-private partnerships among higher education institutions and industry partners, policymakers can address the workforce development equation in the economy. Moreover, policymakers can help higher education institutions become better agencies for growing human and social capital by encouraging and investing in the institutions' data infrastructure, collection, and tracking how students are doing after graduating from their programs. Already, states have statewide longitudinal data systems (SLDS) at the preK-12 level. SLDS has been extended through the Student Data Warehouse[7] (graduation, degree and wage data can be integrated into the system over time. Another state example is Missouri. The state saw Rounds 1 through 4 grant awards go to several of its colleges. Leveraging the consecutive grant funding and projects' designs resulted in the

[7] http://studentdatawarehouse.com/

development of a robust statewide workforce development data warehouse with wage data (Busick-Drinkard, 2018).

2.0 Introduction & Overview

Figure 1: AZ RAMP Up Counties

In September 2014, the Department of Labor's TAACCCT program awarded a consortium of four Arizona community colleges—Central Arizona College (CAC)[8], Eastern Arizona College (EAC), Estrella Mountain Community College (EMCC) and GateWay Community College-Central City (GWCC)—a Round 4 grant to launch a project that would transform the colleges' advance manufacturing programs, address the industry-workforce gap in the central and eastern region of the state, and help the region's residents to recover from the Great Recession. The colleges developed the Arizona Regional Advanced Manufacturing Professional Upgrade (AZ RAMP UP) project to "deliver competency- based training that provides TAA-eligible workers and other adult learners with the skills and credentials they need to secure well-paid work in the growing advance manufacturing sector" in urban Maricopa county (Phoenix metropolitan area), and rural Graham, Geenlee, Gila, and Pinal counties (AZ RAMP UP proposal narrative, p. 13; see also Figures 1 and 2).

The potential impact of AZ RAMP UP project would be considerable. Together, the AZ RAMP UP consortium colleges catchment area encompassed 25% of Arizona (25,589 square miles) and could potentially serve over 4.3 million residents through more than 475 degree and certificate programs. [9] At the time of the Round 4 competition, the state had an unemployment rate of 6.6% (U.S. Bureau of Labor Statistics, 2018a). The Phoenix metropolitan area alone had a 6.0% unemployment rate (U.S. Bureau of Labor Statistics, 2018b) in an economy that was slowly and unevenly recovering.

Key regional industry sectors in construction, durable manufacturing and mining that historically contributed to approximately 14% of the state's GDP, also required more postsecondary training as

[8] Lead institution and fiscal agent

[9] Listing of degree and certificate programs available through the following: CAC (https://centralaz.edu/resources/catalogs/catalog_2018_2019.pdf), EAC (https://www.eac.edu/Academics/Programs_of_Study/default.shtm), EMCC (https://www.estrellamountain.edu/programs/degree-and-certificate), and GWCC (https://www.gatewaycc.edu/programs)

companies and businesses move toward greater automation and require higher skill sets from their workers (JP Morgan, 2013; ASU, 2014). Based on the Arizona Trade Adjustment Assistance Office estimates, 64% of Arizona's TAA-eligible worker had neither a post-secondary credential nor a vocational credential (2014).

Figure 2: Locations of AZ RAMP UP consortium colleges

Legend: CAC = Central Arizona College, **EAC** = Eastern Arizona College, **EMCC** = Estrella Mountain Community College, **GWCC** = GateWay Community College-Central City

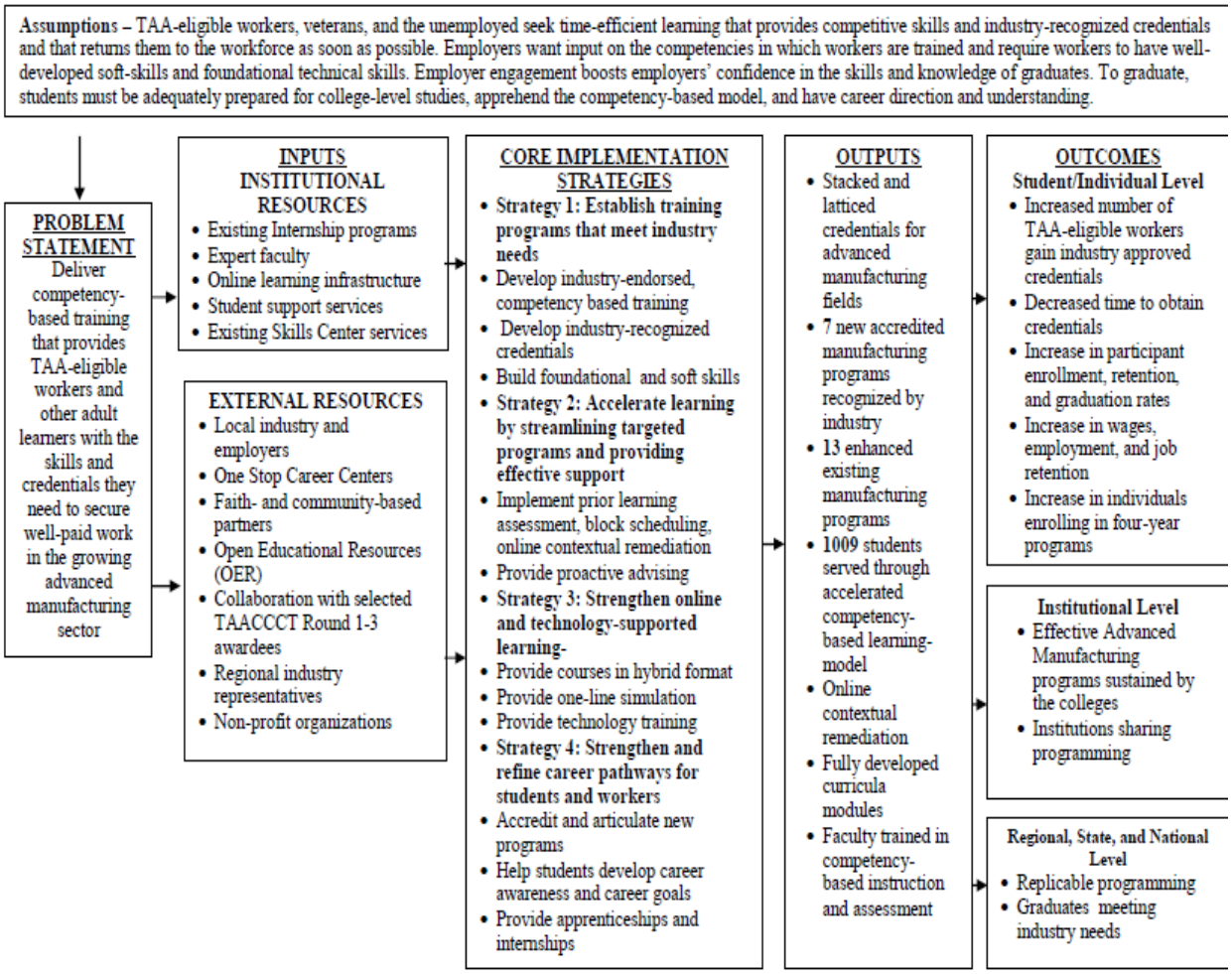
The TAACCCT grant fund afforded the AZ RAMP UP consortium colleges the opportunity to meet these workforce development needs in these industry sectors by to transforming their career and technical education programs and student supports. Specifically, the AZ RAMP UP consortium colleges focused their efforts on seven high-growth, high-wage occupations that cut across these sectors:

- **manufacturing, engineering technologists:** 6% job growth (2014-19) with median hourly salary of 27.23;
- **welder:** 6% job growth with median hourly salary of $18.68;
- **machinist:** 6% job growth with median hourly salary of $20.42;
- **CNC machinist:** 9% job growth with median hourly salary of $18.58;
- **electronics instrumentation technician:** 4% job growth with median hourly salary of $27.72;
- **mechanical engineering technician:** 7% job growth with median hourly salary of $25.22; and
- **maintenance and repair general worker:** 8% job growth with median hourly salary of $16.33 (EMSI, 2014).

To transform their programs and support, the AZRAMP UP colleges advanced four core implementation strategies as shown in the logic model below (see Figure 3). The AZ RAMP UP project would

1) establish training programs that meet industry needs
2) accelerate learning by streamlining targeted programs and providing effective support
3) strengthen online and technology-supported learning, and
4) strengthen and refine career pathways for students and workers.

Figure 3: AZ RAMP UP Logic Model (from the Project Narrative)



Leveraging previous experiences with earlier TAACCCT grants, human and fiscal capital and existing organizational infrastructures and processes, the consortium colleges projected that by the close of the TAACCCT grant, AZ RAMP UP would have

- developed stacked and latticed credentials
- designed 7 new, accredited, and industry-recognized programs
- enhanced 13 existing programs
- established online remedial education aligned to the programs' core requirements
- developed curricula modules, and

- trained a cadre of instructors and faculty members well-versed in competency-based instruction and assessment.

Furthermore, AZ RAMP UP was expected to matriculate at least 1,009 participants who would inevitably acquire industry-recognized credentials and secure high-demand, middle-skilled employment, with commensurate increased wages and compensation and a pathway toward further education and advancement. Through the project, the consortium colleges would have provided much-needed, effective and sustainable workforce training and development for the region.

The AZ RAMP UP consortium colleges secured the services of MN Associates, Inc. (MNA), to be the third-party evaluator to conduct the evaluation study of the grant. MNA's evaluation study design for the grant had two major components: 1) program implementation study (formative evaluation) and 2) outcomes and impact study (summative evaluation). The latter composed of a quasi-experimental design using a prior cohort comparison group. Both the implementation and outcomes and impact study components were developed to inform the work of the consortium colleges, their respective community college networks and public school systems, industry and workforce investment partners, and the larger communities of Maricopa, Graham, Geenlee, Gila, and Pinal counties.

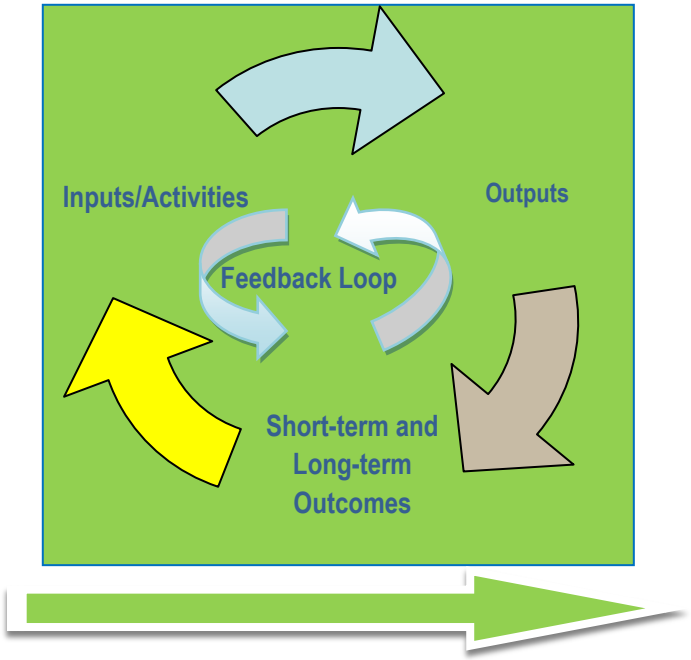
This final evaluation report provides the cumulative results of the implementation study and the final results from the outcomes and impact study. The report is organized to address the following:

- evaluation design and data collection approach
- findings from the implementation study
- findings from the outcomes and impact study
- best practices and lessons learned
- implications for workforce and education research and workforce development practices

3.0 Evaluation Design

In both design and operation, the evaluation of AZ RAMP UP closely followed two aligned models: the logic model developed by the project (shown in Figure 3) and a more general formative and summative evaluation approach that guaranteed a feedback loop for continuous improvement for the various stakeholders of the project (see Figure 4) to help them in their efforts. Figure 4 also illustrates the complementary nature of the implementation (formative) evaluation and impact (summative) evaluation study, with the understanding how contextual force outside of the project influence both the implementation and outcomes of the project.

Figure 4: Implementation, outcomes and impacts evaluation with a continuous feedback loop



The evaluation was designed to benefit the following stakeholders: AZ RAMP UP project team, employers who desire AZ RAMP UP training for current and future employees, instructional technology staff/faculty, academic planners at the colleges and universities, industry and community partners, and other current TAACCCT grantees. With these stakeholders in mind, the evaluation had three goals:

1) Assess the extent to which the career pathways funded by AZ RAMP UP TAACCCT grant improve employment outcomes of participating students across the consortium colleges compared with students from traditional certificate and certification programs;
2) Understand the project's implementation to inform current and future projects, the scaling of successful programs, and to help interpret project outputs and outcomes; and
3) Develop and implement tools and procedures to improve the consortium's institutional capacity to engage in continuous discussions around program improvement, in particular by using:
   a) Internal data (such as student records, course evaluations, student surveys and assessments, instructor and project staff feedback) and external data (such as labor market data and employer/industry data) to make evidence-based decisions to improve programs during and after the grant period; and
   b) Staff and employer/industry partner feedback on the extent to which AZ RAMP UP project's processes are working in meeting employer/industry needs.

The AZ RAMP UP project evaluation design and operation also closely followed the TAACCCT grant evaluation and reporting requirements pertaining to the project's design, implementation and impact. Table 2 showcases crosswalk of the relating to design, implementation and impact of AZ RAMP UP and the corresponding evaluation questions. Specific data collection evaluation practices and research analyses are further articulated in subsequent sections (see 3.1 Implementation Design and 3.2 Impact Design).

Table 2: Crosswalk of project strategy, design, implementation and impact with corresponding evaluation questions

Project Areas	Evaluation Questions
Strategy, Design and Implementation: Curriculum	*How were the particular curricula selected, used, and/or created?*
	How was the AZ RAMP UP program design improved or expanded using the grant funds?
	To what extent were programs at the AZ RAMP UP consortium colleges aligned with university program(s)?
	What delivery methods were offered, and how did participants experience them?
	To what extent were the competencies identified by industry represented in the curricula?
	What were the challenges in the AZ RAMP UP courses and assessment development per program?
Strategy, Design and Implementation: Assessment Tools and Process	*What were the challenges in the AZ RAMP UP courses and assessment development per program?*
	Was an in-depth assessment of participants' abilities, skills, and interests conducted to select participants for the grant program?
Strategy Design and Implementation: Outreach, Recruitment and Support	*What outreach and recruitment strategies are in place?*
	What support services and other services did AZ RAMP UP offer?
Design and Implementation: Partner Collaboration	*What contribution did each of the partners make in terms of: 1) program design, 2) curriculum development, 3) recruitment, 4) training, 5) placement, 6) program management, 7) leveraging of resources and commitment to program sustainability?*
Project Impact: Participant Outcomes To Date	*To what extent are participants satisfied with courses/offerings and their relevance to job market?*
Operational Strengths of the Project, Opportunities for Improvement	*What, if any, challenges emerged in the implementation process? How were the challenges resolved?*
	What were the lessons learned?

3.1 Implementation Design

MNA conducted the investigation into the AZ RAMP UP project's strategies, design and implementation using various data collection tools and sources to help the document what was occurring on the ground. Table 3 summarizes those data tools and sources along with the analyses used to make sense of the data collected. The use of multiple sources and tools helped corroborate what was happening on the ground from various stakeholders. Critical to the investigation were the site visit tours on October 12-15, 2015, January 24-27, 2017, and February 12-17, 2018. Each site visit tour occurred with a visit to each of the consortium college, tours of the classrooms, labs and facilities impacted by the TAACCCT grant, classroom observations, examination of participants' work and artifacts, and focus group discussions and interviews with stakeholders of the project. During these site visits MNA evaluation team members met with the following stakeholders:

- Regional project director who oversaw the entire AZ RAMP UP grant
- Academic deans, department chairs, and grant administrators
- Site directors (by consortium college)
- Instructors
- Curriculum directors
- Career navigators/business partnerships and outreach specialists
- Workforce development coordinators
- Support staff (data, research and development for comparison group discussion)
- Industry, business, and workforce development partners
- Current participants and completers

Discussions and interviews were audio recorded, and with the last site visit, video-recorded as well.

Table 3: Crosswalk of evaluation questions with data collection and data analyses

Evaluation Questions	Method-Data Source(s)		Analysis strategy
Project Strategy and Design			
How were the particular curricula selected, used, and or/created?	Consortium project team and Project documents	Interviews, Data document review/program planning	Qualitative narrative analysis
How was the AZ RAMP UP program design improved or expanded using the grant funds?	Consortium project team and Project documents	Interviews, Data review, Program planning	Qualitative narrative analysis

Evaluation Questions	Method-Data Source(s)		Analysis strategy
What outreach and recruitment strategies are in place?	Consortium project team, Project documents	Interviews, Document review	Qualitative-Themes and Codes of Narrative data
What support services and other services did AZ RAMP UP offer?	Consortium project team, Students, Project documents	Interviews and documents	Qualitative narrative analysis
To what extent were programs at the AZ RAMP UP consortium sites aligned with university program(s)?	Planning meetings	Interviews	Qualitative
Project Implementation			
What delivery methods were offered and how did students experience them?	Consortium project team, Project documents, Students	Interviews, documents, and surveys (students)	Qualitative narrative analysis; Quantitative-descriptive statistics
What was the AZ RAMP UP administrative structure?	Consortium project team and Project documents	Interviews and documents	Qualitative narrative analysis
How did the collaborative model work?	Consortium project team, Project documents	Interviews	Qualitative and Descriptive
To what extent were the competencies identified by industry represented in the curricula?	Consortium project team, Project documents	Interviews and Document review	Qualitative
What were the challenges in the AZ RAMP UP courses and assessment development per program?	Consortium project team	Interviews, Document review	Qualitative-summary of what changes were made
Assessment			
Was an in-depth assessment of participants' abilities, skills, and interests conducted to select participants into the grant program?	Consortium project team, Students	Interviews, Data review, Administrative data	Qualitative and Quantitative - Descriptive statistics
Stakeholder Roles and Contributions			
What contribution did each of the partners make in terms of: 1) program design, 2) curriculum development, 3) recruitment, 4) training, 5) placement, 6) program management, 7) leveraging of resources, and commitment to program sustainability?	Consortium project team, Project documents	Interviews, surveys, and Document review	Qualitative-Themes and Codes of Narrative data

In addition, MNA evaluation team members participated in monthly consortium calls in which all the AZ RAMP UP project staff—composed of the Regional Project Director, academic deans, department chairs, and grant administrators, site directors, career navigators/business partnerships outreach specialists, workforce development coordinators, and support staff— met in person and/or by teleconference calls to discuss their projects progress and coordinate activities. Throughout the course of the grant, MNA evaluators collected and reviewed documents generated through the grants such as program brochures, program course of study, and quarterly reports submitted to the U.S. Department of Labor. Lastly, surveys were collected from stakeholders, particularly participants and partners in business and industry.

In keeping with maintaining a feedback loop for stakeholders MNA provided periodic reports to the Regional Project Director for wider dissemination. These reports included

- a year 1 site visit report (January 2016)
- an early implementation report (February 2016)
- a years 2 and 3 site visit report (February 2017)
- an interim evaluation report (April 2017), and
- a years 3 and 4 site visit report (March 2018).

3.2 Outcomes/Impact Design

The AZ RAMP UP project collected participant data using Social Solutions relational database over the course the grant. Data collected at the participant-level data included

- demographic data (e.g., age, gender, race/ethnicity)
- special status (e.g., veteran, Pell grant, TAA-eligible)
- program performance (e.g., credits received, completion),
- wage data, and
- career navigator case notes.

AZ RAMP UP project staff made the data available to the evaluation team in downloadable spreadsheets. The evaluation team aggregated individual-level data across the four-years of the grant period of performance. Due to the process of aggregating quarterly and semi-annual data submissions, data such as the last date of participation, credits earned, completion, and certificates earned in the sample may not reflect what was included in the Annual Performance Report to the Employment and Training Administration (ETA).

MNA attempted to collect comparison group data from CAC, EAC, EMCC, and GWCC, with each consortium college selecting a comparable group to match against the AZ RAMP UP participants enrolled in their respective colleges. However, due to lack of consistent outcome data for the comparison group, MNA adopted a pre-and post-program within group design to measure the project's impact. Participant wages were collected through self-reported surveys. Statistical tests were conducted to measure the significance of the difference between the pre- and post-completion wages.

3.2.1 Participant Data

Participant data analysis consisted of frequencies of outcome measures by consortium college taken through March 2018 and through June 2018. Evaluators cross-tabulated the number of completed certificates and credentials by college. This analysis was not viable to conduct by demographic characteristics since we did not observe much variation in the data by variables including age, gender, and ethnicity. Evaluators also created variables to determine the number of students who completed a certificate or credential, did not complete and withdrew, and did not complete and were still enrolled. These data were then cross-tabulated with variables such as Pell Grant status. Lastly, the evaluators created variables for participants who completed their certificate or credential within the appropriate amount of time for their program and those who took longer.

3.2.2 Data Analysis

Analyses of data pertaining to the AZ RAMP Up evaluation consisted of a variety of qualitative and quantitative methods. Data from each collection source were analyzed separately, and then compared for consistent or conflicting findings. Advising case management data from over 500 case notes from all years of the project were coded manually for common themes. Statistical analyses were conducted using the software package R. Statistical tests were conducted to make inference(s) about the difference in post-completion mean wages between the treatment and control groups.

3.2.3 Data Caveats

As mentioned earlier, all wage data provided by the participants were self-reported and were not corroborated by any other data. Furthermore, not all participants provided wage data from employment prior to, during, or after completing an AZ RAMP UP program. Thus, wage data calculations were based on data available at the time. In some cases, low N-sizes precluded any consequential calculations to report.

4.0 Implementation Findings

Overall the AZ RAMP UP project implemented the project as designed, with some deviations. Personnel turnovers in the first year and a half of the project created delays that rippled through the project, particularly in three of the four consortium colleges that experienced critical personnel turnover: regional project director, AZ RAMP UP research/program specialist, curriculum program developer and instructor (EMCC), and instructors (CAC, EMCC, GWCC). The hiring of a permanent regional project director steered the project's implementation back on track.

The AZ RAMP UP project utilized the TAACCCT grant award to successfully execute the four proposed strategies expressed in the logic model. In order to develop new and enhanced programs, the consortium colleges purchased new equipment and renovated their facilities. At the same time they created new curricula and revised old curricula to incorporate the new equipment and facilities. The new and revised curricula were reviewed by industry partners to ensure that they align with the needs of the industry (Strategy # 1). The new and revised programs incorporated web-based learning tools such as Tooling U, NCCER Connect, Surfcam and learning management systems such as Canvas and Blackboard to facilitate blended learning (Strategy #3). Participants studied the material at their own pace. Since they were utilizing Tooling U, NCCER Connect and/or Surfcam, the participants were also assured that the materials were tied to the industry-endorsed credentials such as the American Welding Society and the National Institute for Metalworking Skills. Thus, while completing the coursework, the participants were also eligible to earn industry-endorsed credentials along the way.

Across all the consortium colleges, participants worked in labs with their cohort groups in blocks of time designed to maximize and accelerate their learning in the shortest amount of time possible (Strategy #2). For participants enrolled in AZ RAMP UP programs at CAC, EAC, or EMCC, earning a certificate and degree started them on a path towards further education at either Arizona State University of North Arizona University (Strategy #4). The career navigators were available and assisted participants along the way from enrollment to job placement. The career navigators provided proactive advising to ensure participants stayed on track towards certificate and degree attainment and employment in their studied field.

Further details of the AZ RAMP UP project implementation are provided below.

4.1 Consortium Structure and Project Administration

The AZ RAMP UP project maintained a consortium structure that recognized the autonomy of each of the consortium colleges. The TAACCCT grant funded a site director (project director) for each site, with EMCC and GWCC which are both part of the Maricopa County Community College

District (MCCCD) sharing the same site director. The site director oversaw the day-to-day administration of AZ RAMP UP at their respective college which covered student recruitment, enrollment and retention, curriculum and instruction, job placement for completers, and data and accounts processing and management. In addition, a career navigator was also hired through the grant for CAC, EAC and GWCC and supported the work of a workforce development coordinator at EMCC.

The site directors reported to their respective college's administrators and communicated with the regional project director who oversaw the entire AZ RAMP UP project. CAC as the lead institution and fiscal agent for the grant hired the regional project director, administrative assistant, and data manager. The data manager oversaw the data collection across the consortium colleges. The data manager was also responsible for ensuring that all staff members involved in sharing of the data were trained and entered the data accurately and in a timely manner for data sharing with the external evaluator and reporting with DOL. The regional project director was the liaison for the DOL federal programs officer (FPO), and the consortium colleges and oversaw coordination across all the consortium colleges, including evaluation. Figure 5 outlines the organization of the AZ RAMP UP Project.

Project administration hit a few obstacles early in the grant period. In particular, delays in year 1 rollout resulted from compounding grant implementation and management issues such as slow communication, lack of grant management norms and procedures among the consortium colleges, prolonged process for approval of revisions of competency-based programs through college boards and accreditation boards, prolonged approval process for purchases of supplies and equipment through college, consortium, prolonged project kick-off and inopportune changes in staffing and leadership. At the center of the difficulties was the turnover for the regional project director position that would have facilitated the administration of the project through these turnkey activities. The original regional project director left the position in September 2015, resulting in an interim regional project director from September 2015 through May 2016, when the current regional project director began his tenure. Thus, near the end of year 1, only two colleges had enrolled participants for the AZ RAMP UP project based on enhancements to pre-existing programs: CAC for its welding program (42 participants) and EAC for its machinist/manufacturing and drafting programs (61 participants). Towards the end of year 2, the hiring of permanent staff to fill the regional project director of the grant and key personnel for new or vacated positions—research/project specialist and data manager (AZ RAMP UP), curriculum developer and instructor (EMCC), and career navigator (GWCC, EMCC), instructors (across all sites)—helped put the project back on track.

Another significant source of implementation difficulty emanated from AZ RAMP UP's vendors. AZ RAMP UP hired the services of Amplifund© (budget expenditure tracking and progress-to-goals tracking), Social Solutions© (participant tracking and wage data scorecard), and MATEC (curricular improvements). All three vendors failed to fully meet their agreed-upon scope of work. Amplifund's data applications and services were duplicative of the applications and services that Social Solutions provided. Amplifund's system was also riddled with technical problems, resulting in a termination of services after a year, with a loss of both time and resources as a result. The Social Solutions system struggled to track participant data without significant manual interventions and constant reviews from the data manager, site directors and career navigators. Lastly, MATEC was tasked to assist the consortium colleges in building up its capacity in curriculum development through 1) the establishment of advisory bodies at the college and consortium levels, 2) modularization of new and enhanced curricula, 3) module development and design templates and guides, 4) and contextualizing remediation through select, customized videos and simulations. MATEC was disbanded as a corporate entity having partially met its deliverables. As a result, AZ RAMP UP program staff took on the remaining unmet tasks in order to meet the project deliverables for the grant.

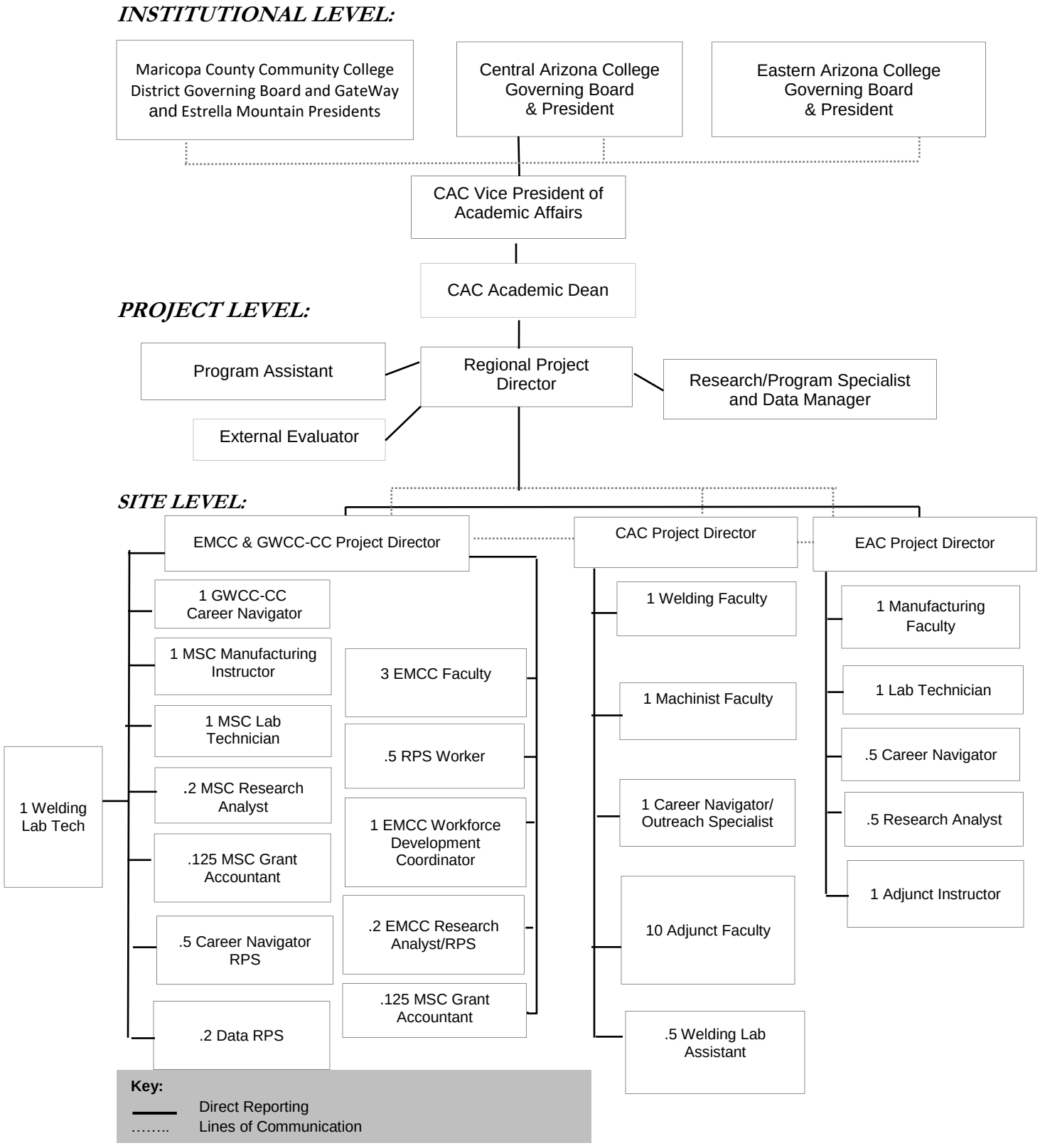
As the AZ RAMP UP project matured in the year 3 with all the new and enhanced programs in place, responsibilities of the AZ RAMP UP project personnel shifted toward sustainability. Specifically, across all the AZ RAMP UP consortium colleges, key staff members focused more of their attention to nurturing deeper and more relationships with workforce development partners and industry partners. For example, in year 1 the CAC project director work focused on overseeing the renovations of classrooms and labs spaces and the procurement and installation of new equipment. Towards the end of year 2 and onward, her focus shifted to building relationships with industry partners and working with college administrators to develop apprenticeship and internship programs with industry partners. In addition the CAC project director worked with welding instructors and industry partner Sundt construction to building a cement pad in the outdoor classroom lab that simulated the real conditions that participants in the welding program will encounter in the actual work sites.

Similarly, once the programs were up and running, more emphasis was placed on marketing the programs both with industry partners and with potential students. For example, GWCC's project director and career navigator, and EMCC's workforce coordinator and workforce development in partnership with Arizona@Work Work Maricopa County co-hosted an advanced manufacturing event to bring awareness to career opportunities in advanced manufacturing and construction to high school seniors, recent high school graduates, and incumbent workers to meet with industry partner and learn more about the colleges' respective programs. Along the same lines, the EAC project

director worked with instructors and college administrators and created new and revised marketing brochures that illustrate how courses and credits were aligned to industry-recognized credentials and provide a pathway to fulfilling careers. EMCC also brokered breakfast meetings with industry partners to showcase how their programs, particularly in the power plant and IMET programs, could provide the skilled workforce the partners were searching for.

Finally, instructors across all the programs and consortium colleges provided more than just guidance and expertise in the classroom. In several instances instructors were change agents in transforming unspecified interests into program enrollment, completion and job placement: Across all sites, instructors played a critical role in the success and sustainability of the program. They were gatekeepers to the industry through their content expertise, connections, experience, industry contacts and through their instructional pedagogy that brings the working world into the classroom.

Figure 5: AZ RAMP UP organizational chart



4.2 Strategies, Activities and Deliverables

AZ RAMP UP consortium colleges were able to implement nearly all the strategies and deliverables by the close of the grant. Table 5 unpacks the strategies, activities and deliverables highlighted in the logic model.

Table 5: Status of AZ RAMP UP strategies, activities, and deliverables to date

Status	Strategies, Activities, and Deliverables
⊙	Project administration
⊙	Data collection, evaluation & reporting
●	Advisory boards
●	Renovation and new equipment purchase & installation
●	Stakeholder involvement with workforce system, education system, etc. for student recruitment, marketing and student services
●	Flat fee
●	Work readiness program and assessment
●	Streamlined programs & stacked and latticed credentials
●	Competency-based modules
●	Career navigators and pro-active advising
●	Enhanced, technology-enabled learning
●	Technology support and assessment
●	Distance learning opportunities
●	Apprenticeships and internships
◗	Articulation agreements and pathways to 4-year degree programs

Met = ● ; Ongoing = ⊙; Partially met = ◗; Did not meet = ○

There were only three exceptions to note. First, project administration is expected to continue through the end of the September. Secondly, additional tracking and reporting of wage data are slated through December 2018. Finally, articulation agreements and pathways to 4-year degree are marked as half met. All the consortium colleges had intended to create pathways for participants interested in leveraging certificates and associated degrees earned through TAACCCT-supported grants CAC, EAC, and EMCC have been successful in partnering with 4-year degree institutions. The only exception was GWCC. AZ RAMP UP programs at GWCC were certificate programs earned through clock hours. Within the MCCCD system, no policy has yet been determined to create clock- to credit-hour equivalency that could then be taken to 4-year degree institutions.

While Table 5 indicates that the flat fee deliverable was met, it was done so for the case with EAC only. EAC has instituted a modified flat fee tuition structure for students who were enrolled in

over 15 credits. CAC explored the use of a flat fee for its competency-based welding program. However CAC abandoned the strategy after learning that a flat fee tuition would increase participants' cost to enroll in the program based on the way the courses were structured.

Some of the activities noted above as having been met were completed two and half years into the grant period or earlier. For example, the consortium colleges had their own local-level advisory boards to review their curriculum specific to their area or industry sector by December 2016 and had streamlined their programs with stacked and latticed credentials by February 2017. Others took longer than expected such as the activities with facilities renovation and equipment purchase and installation, which was not wrapped up until May 2017. Three activities were concurrently met because of the integrative properties of web-based technology to facilitate competency-based modulation of curricula to deliver enhanced, technology-based distance learning. All four consortium colleges subscribed to one or more of the following technology-enabled learning management systems recognized by industries and aligned were aligned with industry credentials: Tooling U, NCCER Connect and Surfcam.

Finally, some of the activities have continued beyond the grant period. Notably, the use of technology-enabled learning, work readiness assessment and proactive advising via a career navigator were met and sustained beyond March 2018, which marked the end of the no-cost extension period.

4.3 Renovation and New Equipment Installation

A key feature of the AZ RAMP UP had been the renovation of facilities and upgrading equipment. Picture taken during site visits over the course of the grant show the transformation of the facilities across all four colleges. Moreover, in some cases the facilities have expanded beyond the original plans for the grant. For example, welding instructors at CAC have expanded the lab space to incorporate the outdoor area outside the renovated indoor lab to provide additional real-life work spaces for participants in the welding program to hone their skills. In another case EMCC moved the current and recently purchased equipment and consolidated them in the West-MEC campus. Select pictures are featured in the Appendix section of this report.

4.4 New and Enhanced Programs – Curriculum & Instruction

AZ RAMP UP project had targeted 13 programs for enhancement and 7 new accredited manufacturing programs to launch. By March 2017, the project had successfully enhanced 19 existing programs and launched 8 new programs. The number of programs expanded through grant modifications. GWCC filed for and received DOL's permission through a grant modification to include welding technology to AZ RAMP UP, effective April 25, 2016. EMCC filed for and received DOL's permission through a grant modification to include power systems technology to AZ RAMP

UP, effective October 11, 2016. All the programs incorporated industry-endorsed credentialing within the curriculum. Participants who successfully learned and completed tasks embedded within the curriculum became eligible to sit through a certification examination, such as earning a NIMS Level 1 certification through the CNC Machining program at GWCC. Table 6 below showcases all the programs and identifies them by consortium college and program.

Table 6: 27 New and enhanced AZ RAMP UP programs through the TAACCCT grant

Consortium College/Program Name (*Degree Programs in Italics*)[10]	New (N=8)	Enhanced (N=19)
Central Arizona College (5 – 3 new, 2 enhanced)		
Structural Welding		✓
Pipe Welding	✓	
CNC Machining	✓	
Manufacturing Engineering Technology		✓
Industrial Maintenance	✓	✓
Eastern Arizona College (11 – 4 new, 7 enhanced)		
Advanced Manufacturing Technology	✓	
Fab Lab Technician	✓	
Manufacturing and Design Technician	✓	
Manufacturing Engineering Technician	✓	
Computer Assisted Design & Drafting Technology		✓
Computer Assisted Design & Drafting Technology Level I		✓
Computer Assisted Design & Drafting Technology Level II		✓
Electrical and Instrumentation Technology		✓
Electrical and Instrumentation Technician		✓
Welding Technology (degree and certificate programs)		✓
Estrella Mountain Community College (5 – 1 new, 4 enhanced)		
Industrial Manufacturing and Emerging Technologies	✓	
Electronic Systems Technology		✓

[10] Note that with the exception of programs provided through GWCC, programs are based on credit hours. GWCC programs are based on clock hours.

Consortium College/Program Name (*Degree Programs in Italics*)[10]	New (N=8)	Enhanced (N=19)
Mechatronics Level I		✓
Mechanical Systems Technology		✓
Power Systems Technology		✓
GateWay Community College-Central City (6 – all enhanced)		
Manual Machining		✓
CNC Machining		✓
Welding		✓
Advanced Welding I		✓
Advanced Welding II		✓
Advanced Welding III		✓

Since the programs were developed and began enrolling participants, curriculum revisions have occurred based on feedback from advisory board members, industry partners and completers who found employment in their trained area. Revisions helped ensure that the programs continued to reflect industry needs by showing greater alignment to the content and skills industry partners expected from program completers. For instance, CAC welding instructors learned from employed completers and industry partners that program participants needed more exposure and practice in real-world troubleshooting and problem-solving strategies. Thus, the instructors developed the outdoor classroom area mentioned earlier. In another example, EMCC's Power Systems Technology program shared the same curriculum as the ongoing professional development and training provided to current employees at the Palo Verde Generating Station, (PVGS) the nuclear power plant station near Phoenix and a major employer in the region. This ensured that completers of the program can seamlessly take part in the human capital supply chain as employees of PVGS.

While business partners, current program participants and program completers suggested ways to tinker and tweak the AZ RAMP UP programs' curricula overall, they reported a great deal of satisfaction with it. Across the programs, the AZ RAMP UP curricula was found to be more than sufficient to provide a firm foundation for program completers seeking entry-level positions in numerous industry sectors.

Focus group discussions across all the colleges revealed that participants of AZ RAMP UP programs have experienced the industry-endorsed curricula through a hybrid learning format. Participants studied at their own pace concepts, basic information, and theoretical underpinnings through online, industry-endorsed curricula. This was achieved through technology-enabled learning

platforms such as Tooling U, NCCER Connect and Surfcam. Additional material and resources were provided through the consortium site's learning management system (LMS), namely Blackboard and Canvas, and in-class lectures and demonstrations. Lab time during class provided participants the opportunity to 1) integrate and practice what they have learned online, and 2) develop proficiency in executing the procedures they need to succeed in a performance assessment given as part of the industry-credentialing process, and 3) learn and hone career and work-related soft skills. All four AZ RAMP UP colleges moved to a block or cohort scheduling to enable students to have peer support and extended use of the lab over longer time blocks.

4.4.1 Stacked and Latticed Credentials

AZ RAMP UP also acquired the services of MATEC, as the project curriculum developer in spring 2016 to assist with modularizing existing curriculum and provide additional resources such as graphics, simulations, animation, and tools for instructors and participants in a move to establishing the AZ RAMP UP programs as competency-based education (CBE) programs. As a first step toward modularizing existing curriculum, MATEC conducted a review of the course of study of all the AZ RAMP UP-supported programs. Sixty-eight unique courses and 681 measurable student learning objectives (MSLOs) were found and analyzed. MATEC released a January 2017 report which provided a course-by-course analysis; suggested competencies based on the MSLOs; and recommended additional industry-recognized credentials per program.

In addition to industry-endorsed credentials from NIMS, NCCER, NCRC and OSHA[11] (see Table 7), MATEC also recommended other industry credentials from the Association for Packaging and Processing Technologies (PMMI), from NIMS for industrial technology maintenance, SME credentials for additive manufacturing, Autodesk for the Fab Lab technician program, and Siemens Mechatronics Systems certification for the mechatronics program. The report also provided a glimpse into the similarities, differences and overlaps of programs and curricula across the consortium member sites. The report featured six recommendations for the consortium:

1) Optimize program instruction by aligning knowledge and skills covered over the program course of study with those required to successfully obtain industry-recognized credentials;
2) Develop a set of clear and focused competencies per course using MATEC's proposed competencies, an AZ RAMP UP program course's MSLOs, and industry partners' input;

[11] AWS = American Welding Society, NCCER = National Center for Construction Education and Research, NIMS = National Institute for Metalworking Skills, NCRC = National Career Readiness Certificate, OSHA = Occupational Safety and Health Administration.

3) Develop a set competency observations rubrics and performance evaluation instruments aligned that can provide valid and reliable interpretations of participants' abilities; and
4) Approach modularization with caution until a clear idea has been envisioned on how the modules fit within a program and certification system.

GWCC utilized NIMS (Machining), and AWS and NCCER (Welding) for establishing competency-based education modules for its AZ RAMP UP programs. EMCC uses NCCER for its AZ RAMP UP programs. CAC has devised its own CBE modules for structural welding and pipe welding using AWS and NCCER. Both welding certificate programs modules work using block scheduling, and have been approved by the CAC's Academic Curriculum Committee and the Arizona Higher Learning Commission. Tables 8 and 9 provide illustrative snapshots into what MATEC found and reported in its analysis of the AZ RAMP UP programs' curricula.

Table 7: Industry-recognized credentials within AZ RAMP UP program courses

Industry Field/ Content Area	Industry-Endorsed Curriculum	Industry-Endorsed Assessment	Industry-Recognized Credentialing Organization	Consortium College Examples
Welding	NCCER Connect (online supplementary material)	NCCER	AWS	**CAC: WLD 121** is an introductory course to shielded metal arc welding (SMAW). Completion of the course supports knowledge and skills for sitting for NCCER Welding Level 1 assessments.
CNC Machining	Tooling U-SME (online material and simulation)	NIMS	NIMS	**GWCC: MTO 190** is an entry-level course for machining that introduces lathes, mills and grinding machines. Completion of the course supports knowledge and skills for sitting for the NIMS Level 1 assessments.
Workplace Safety and Health	OSHA	OSHA-10	OSHA	**EMCC: MIT 120** is an introductory course into the theory and basic concepts of industrial technology basics and workplace safety. Completion of the embedded OSHA 10-hour training session and accompanying documents results in proof of completion OSHA card.
Career Readiness	KeyTrain and WorkKeys Prep (online)	WorkKeys	NCRC	**EAC: TEC 090** is an online developmental course to strengthen academic –related skills in

Industry Field/ Content Area	Industry-Endorsed Curriculum	Industry-Endorsed Assessment	Industry-Recognized Credentialing Organization	Consortium College Examples
				participants in career and technical education programs. Participants can earn an NCRC recognition after successfully passing three assessments.

Table 8: Connecting Measurable Student Learning Objectives with Competencies for ELT 110 - Example

ELT 110 Electricity and Electronics

http://www.eac.edu/Academics/wids/ELT110.pdf

This course is an introductory course into the basic principles of electricity and electronics theory with a heavy emphasis on industrial applications. Students will be introduced to the study of various blueprints, schematics, wiring diagrams, and symbols as they are used in practical industrial applications. The student will learn the electrical concepts and terminology of voltage, amperage, and resistance. The student will learn to solve electrical problems by use of Ohm's Law formulas.

Measurable Student Learning Outcomes	Proposed Competencies
1. Understand Basic Electrical Theory 2. Read Blueprints, Electrical Schematics, and Symbols	1. Identify the electrical quantities and interrelationships of charge, potential difference, current, and resistance given the standard unit in which each is measured. 2. Identify common electrical and electronic components, and their corresponding schematic symbols. 3. Use appropriate mathematical models to predict circuit component parameter values and circuit power needs. 4. Construct or simulate, measure, and correctly evaluated the characteristics of series and parallel circuits. 5. Correctly determine the equivalent resistance, current, and voltage drops for each element in series and parallel circuits.

Table 9: Alignment to Credential for GWCC Welding Program - Example

GWCC Welding Program	
Potential Credential(s)-	**Welding I** (648 clock hours)
NCCER Welding Level 1	
Welding Safety	Oxyfuel Cutting
Plasma Arc Cutting	Air-Carbon arc cutting and Gouging
Base Metal Preparation	Weld Quality
SMAW Equipment and Set Up	SMAW Electrodes
SMAW Beads and Fillet Welds	Joint fit-up and Alignment
SMAW Groove Welds with Backing	SMAW Open-Root Groove Welds – Plate

While instructors found the findings from the MATEC's report were insightful, their impact to the overall AZ RAMP UP programming was limited by its timing. The colleges' instructors remarked that the analysis and report came when they had already launched the programs. Nevertheless, the findings offered another way that program and curricula could be revised in the future.

4.4.2 Articulation Agreements

Besides earning credit or clock hours for a certificate or degree, and earning industry-endorsed credentials, participants in the AZ RAMP UP programs also gained a strong foothold towards earning a bachelor's degree in applied sciences (BAS) in one of three well-regarded 4-year public universities: Arizona State University (ASU), University of Arizona (UA) and Northern Arizona University (NAU). Table 10 summarizes the articulation agreements that the colleges have with at least ASU, UA or NAU. These articulation agreements were in addition to credit recognition and transfer agreements already in place through AZ Transfer, a statewide collaboration among 21 community colleges, tribal colleges and state universities with a mission to assist students traverse the myriad of options in higher education that is best suited to their needs and aspirations.

GWCC was the only college that did not have an articulation agreement in place for any of its AZ RAMP UP programs. During the grant period efforts were made to arrange for articulation agreements with EMCC and another MCCCD college, Mesa Community College. GWCC was proposing that participants' who earned a clock hours through their certificate in the precision machining be recognized and translate to credit hours toward the IMET degree at EMCC. GWCC was also working toward articulating its clock-hour programs with Mesa Community College. However, those efforts failed to produce an articulation agreement with either sister institution by the time the grant ended.

Table 10: AZ RAMP UP programs with articulation agreements with 4-year universities

Consortium Site	Receiving Institution	Associate's Degree Program	Status and 4-Year Degree
CAC	ASU, NAU, and UA	Manufacturing Engineering*	Bachelor of Industrial Technology Management (NAU)
CAC	NAU	Welding Technology*	Agreement in place
EAC	ASU, NAU, and UA	Welding Technology+	Agreement in place
	ASU, NAU, and UA	Computer Assisted Design and Drafting Technologies+	BAS in Applied Leadership (ASU)
	ASU, NAU or UA	Advanced Manufacturing Technology*	BAS in Applied Leadership (ASU)
EMCC	ASU, NAU, and UA	Power Plant Technology	Agreement in place
	ASU, NAU, or UA	Industrial	Pending at the time of

Consortium Site	Receiving Institution	Associate's Degree Program	Status and 4-Year Degree
		Manufacturing and Emerging Technologies*	end of grant period

* New or enhanced through AZ RAMP UP project grant
+ Specific courses enhanced through AZ RAMP UP project grant

4.5 Career Navigators and Student Support

DOL required all Round 4 TAACCCT grants to have a dedicated staff member, a career navigator, to

- publicize grant-supported programs,
- recruit participants to the programs,
- provide prescriptive and intrusive advising to the participants,
- cultivate relationships with industry partners for the benefit of the participants, and
- help transition participants to full time, gainful employment in their chosen career.

Figure 6: EMCC & GWCC Advance Manufacturing Flyer

For the AZ RAMP UP grants, the career navigator role had different job title. The titles reflected which of the aforementioned duties or areas the college emphasized with their interactions with participants and the degree to which existing student supports personnel at the college could address these duties. At CAC and GWCC, responsibilities for recruiting participants and shepherding them through a program rest on one individual with the title "career navigator and outreach specialist." At EAC, such responsibilities were shared between two people who worked in tandem: the TAACCCT grant-funded career navigator and the Arizona@Work-funded "TAACCCT Career Advisor." At EMCC, the focus had been more on securing internships, externships, and apprenticeships, and forming business partnerships. Thus the staff member involved was appropriately titled "Workforce Development Coordinator."

Publicity and recruitment took up much of the work at the beginning of the grant when programs—especially new programs—were being launched. Towards year 3 and beyond, the career

navigators emphasized job placement, apprenticeships, internships, and carrying and supporting partnerships with industries to support the skilled labor that the colleges were producing, while still keeping up with recruitment efforts. The exceptions to this natural arch of program maturation and human capital pipeline development were among established programs such as CAC's welding program and GWCC's precision machining program. In these cases, the programs' well-regarded reputations preceded the AZ RAMP UP grant and selling the programs required less effort.

Focus group discussions and reviews of case notes from the career navigators revealed that all AZ RAMP UP career navigators addressed all five aforementioned duties that fell under the student supports umbrella. All the AZ RAMP UP career navigators have publicizing the grant programs through all forms of media—print, word of mouth, social media, website, etc., but also visits to one-stop shops, veterans affairs offices, businesses, career fairs, and high schools (see Figure 6). The colleges also capitalized on high-profile events such as the opening of the Fab Lab at EAC and the announcement of Lucid Motors building a plant near CAC. Periodic events such as annual MFG Day in which all the colleges participated and hosting events such as Welders Without Borders Welding Thunder© TM SM Welding Fabrication Team Invitational (CAC) and Skills Expo (EMCC).

The outreach and recruitment efforts revealed early on that high school students and recent high school graduates were the growth areas to market the programs. Military veterans were also another group that proved to be receptive to the programs offered by the AZ RAMP UP project. Conversely, project staff discovered that TAA-eligible workers—the original target audience for the grant—had already re-joined the job market by the time AZ RAMP UP programs were launched.

Conversations with participants and career navigators, reviews of career navigator case notes, and in surveys (discussed further below) demonstrated how proactive advising from career navigators had supported participants and greatly enhanced the project as experienced by the participants. Career navigators at all the consortium sites have provided an array of career advising and planning services. These services included a) assessment of interest and advisement about possible career pathways, b) program enrollment and financial aid, c) participant retention, d)identification of courses to help students meet their career goals, e) activities related to job readiness and the process of employment, and f) assistance with job placement through employer connections and networks and workforce centers. Table 11 provides excerpts and examples of these services.

Table 11: Types and examples of career navigator services

Career Navigator Services	Examples

Career Navigator Services	Examples
Assessment of interest and possible career pathways	*I met with [the student] to assess his situation. He is just beginning the Advanced Manufacturing AAS program. I shared the program course sequencing with him, and gave him an articulated plan to move from the AAS at [college] to the ASU BAS Operations Management that is taught on the [college] Campus.*
Program enrollment and financial aid	*I had an appointment with student in my office regarding financial aid problems. We tried multiple times to request her tax transcript from the IRS from both their website and their alternative phone line. Each time we were able to request the transcript, however we needed to speak to a live person because transcripts ordered through the IRS' automated system were not being delivered to student's home.* *I contacted [student] at [college] financial Aid dept. and he explained that the student could print her 2014 tax forms and print proof that we had tried to order her tax transcripts. The student and I printed her 2014 tax forms and copies of our attempts to order her tax transcripts. We met in Mr. [officer's] room and spent some time trying to help the student retrieve her federal pin number to access her FAFSA account. We eventually had to walk to the information desk to ask for student email help and then had to call IT to have someone walk him through the student's account information. Eventually, [student] was able to resolve the password and email problems and advised the student to return the following week to make sure that all the proper paperwork had arrived and was filed properly.*
Participant retention	One career navigator reported how a participant was required to purchase protective goggles for lab work. At first, the participant was discouraged by the instructions he received that would require him to pay several hundreds of dollars out of pocket for the goggles. The career navigator quickly reviewed what benefits he was eligible for and quickly discovered that the participants qualified for various benefits that paid for his googles. The career navigator was with the participant when he placed the order for the goggles using the benefits.
Linking courses to career goals	*We had a student who had accumulated 160 AC credits but possessed no degree(s). He graduated this past May with 3 AAS Degrees and two technology certificates. I have been in contact with 9 students who planned on obtaining their AAS degree and then stopped. All nine are working toward their 75 credits in technology that will allow them to transfer into the ASU Operations Management degree offered here on campus.*
Job readiness and employment process	Career navigators arranged mock interview panels and matched participants with available internships and apprenticeships
Job placement assistance	Career navigator helped place an unemployed participant find a job in the local power plant station while he complete his associate degree to continue to work and advanced in his chosen field in power systems technology

As shown in Table 11, career navigators frequently took a personal, caring approach to working with participants. This approach helped to foster relationships with the participants and to develop program cohesion and identity and increased the visibility of the career navigator. The hi-touch, hi-impact approach worked particularly well with participant accustomed to personalized customer-client engagement for goods and services and with participants unfamiliar with higher education institution policies and practices.

The career navigators' activities also encompassed the classrooms. Career navigators worked behind the scenes by meeting with the participants' instructors regularly to insure that participants

did not fall through the cracks, and to help bridge the communication gaps that may be forming between instructors and participants.

4.6 Assessment Tools and Processes

Assessments used to determine work readiness, prior learning, and competency were built into the AZ RAMP UP project's curricula with mixed success. For work readiness, GWCC career navigators and instructors administered ACT KeyTrain®. CAC, EMCC, and EAC utilized NCRC. CAC piloted a program within the machining program that offered the National Career Readiness Certificate for machining participants who completed the ACT WorkKeys® course in 2016 and 2017. However, due to the lack of support from the industry, CAC discontinued the practice of NCRC certification in the machining program through the WorkKeys course. EAC had greater success with a work readiness program using WorkKeys as the curricula and NCRC as the assessment. Four participants successfully completed the course and received NCRC certificates. Career navigators used WorkKeys as a diagnostic tool with project participants to assess their work readiness and determine their next steps for their program course of study.

As a TAACCCT grant, AZ RAMP UP is required to assess the participants' prior learning experience upon enrolling in one of the grant-supported programs. The rationale for the process is to alleviate unnecessary remediation by participants on material they already know and also to ascertain their level of proficiency as eligible candidate for potential employers. As mentioned in section 4.5, a greater number of participants of the AZ RAMP UP programs were recent high school students and high school graduates. Thus, prior learning assessment had less bearing with this population since they generally had limited time to develop any expertise. Instructors revealed that even for students who have had career and technical education (CTE) in high school, such as welding, they often enrolled into the programs with limited abilities because they had limited lab time to hone their skills.

Because several of the AZ RAMP UP instructors were also certified test proctors in their field, they were able to conduct performance assessment of a participant's prior learning. The instructors would ask the participant to perform tasks equivalent to what they were required to perform to meet an industry-endorsed credential.. In a few cases, successful participants with prior learning experience received academic credit and could opt out of a required course—such as Welding 121—because of their mastery of the material covered in the course. In most cases however, participants' prior learning was insufficient to propel them to opt out of a required course.

Participants are also assessed if they have sufficient knowledge and skills in arithmetic, computation, and geometry as well as sufficient grasp of written, aural, verbal and technical English to successfully perform in the workplace. As mentioned earlier, all the consortium colleges utilized WorkKeys to determine a participant's ability in applied mathematics and reading for information. In

addition, each consortium site assesses all entering students for course placement in mathematics and English language arts. Based on performance results, the college may recommend remedial coursework for either or both prior to enrollment in the program. At CAC curriculum developers from the mathematics department and engineering technology division created a modularized remedial course called Technical Math (MAT 106/MAT107). Based on the published textbook, *Mathematics for the Trades: A Guided Approach* by Hal Saunders and Robert Carmen (10th ed., 2014), the course repacked the material that would meet the math requirements for the welding program. Successful completion of the modules allowed the participant to proceed with the required coursework of the program. The modules also assisted in diagnosing areas for improvement for which participants could seek additional assistance and tutoring. Table 12 showcases the Technical Math course.

Table 12: MAT 107 Technical Math II

Credit Hours: **4**	Credit Breakdown: **2 Lectures/ 6 Labs**
Effective Term: **Spring 2016**	Times for Credit: **4**
SUN#: **None**	Grading Option: **A/F Only**
AGEC: **None**	Cross-Listed:

Description: Review of basic operations of whole numbers, fractions, decimals, percents and their application to the construction trade. Incorporates the use of tools to measure length and weight. Various mathematical conversions are studied along with practical applications. A study of basic geometry including perimeter, area, volume and geometric constructions. This course also includes a survey of basic algebra as related to the trade. This course is closed entry. Instructor consent required. Students may not receive credit for both MAT106 and MAT107. This course will allow students obtaining a Welding Degree to satisfy all math requirements in one course.
Prerequisites: Closed entry. Instructor consent required.
Co-requisites: None
Recommendations: None

Measurable Student Learning Outcomes
1. (Application Level) Perform basic operations with whole numbers, fractions, decimals and percent.
2. (Application Level) Convert fractions to decimals to percent in any order.
3. (Synthesis Level) Use data represented in graphs to draw conclusions.
4. (Application Level) Solve applied percent problems involving mechanical efficiency, production waste, relative manufacturing error and tolerance.
5. (Analysis Level) Set-up and solve proportion problems including direct proportion, similar figures, roof pitch, scale drawings, etc.
6. (Application Level) Solve applied inverse proportion problems involving gear ratios, lever arms, etc.
7. (Application Level) Convert measurements from U. S. Customary units to metric and vice versa for length, weight, volume and temperature. Express converted quantities to a specified level of precision (e.g. to the nearest sixteenth inch).
8. (Application Level) Make measurements using rulers, calipers and micrometers as well as using scales of the trade.
9. (Analysis Level) Recognize basic shapes used in the trade, identify angles and find missing angle measures.

Measurable Student Learning Outcomes
10. (Application Level) Apply basic geometric concepts to solve problems involving area, perimeter and volume. 11. (Application Level) Apply differing strategies to solve application problems both with and without a calculator. 12. (Application Level) Perform basic operations with signed numbers, exponents and square roots. 13. (Application Level) Use basic algebra concepts to solve applied trade-related problems. 14. (Application Level) Solve applied trade-related problems involving scientific notation. 15. (Application Level) Find the measure of the legs or hypotenuse of a right triangle using the Pythagorean Theorem.
Internal/External Standards Accreditation
None

4.7 Student Engagement

Over the course of the grant, participants completed surveys to determine the origins of their interest to participate in the AZ RAMP UP programs and to assess from their perspectives how the programs were implemented. MNA collected data from all four colleges for five terms, starting with fall 2015 through fall 2017. Table 13 shows the number of completed surveys collected by college and term. About 70% of the sample was drawn from EAC. EAC enrolled the most participants over the grant period.

Table 13: Sample distribution by college and term

Term	CAC	EAC	EMCC	GWCC	Total
Fall 2015	20	44	0	15	79
Spring 2016	8	115	19	0	142
Fall 2016	0	67	0	0	67
Spring 2017	0	125	0	2	127
Fall 2017	50	0	0	32	82
Total	**70**	**351**	**19**	**49**	**497**

Across the various programs, the majority of the respondents to the survey were enrolled in welding, followed by CAD/drafting and electronics. As shown in Table 14, at least one welding program was offered at CAC, EAC and GWCC, and they were noted for having at or near enrollment capacity. EMCC did not have a welding program with the AZ RAMP UP project.

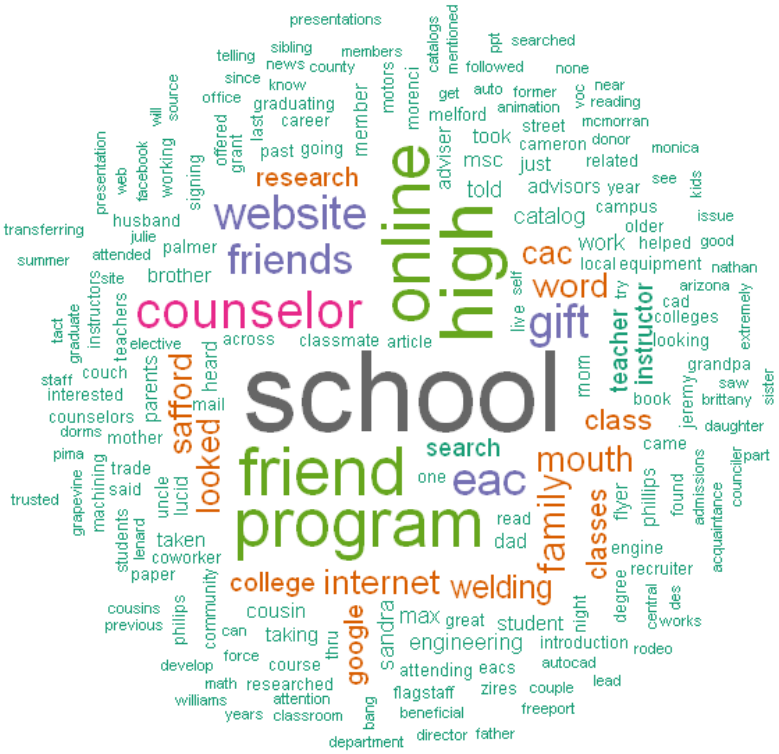
CAD/drafting was offered only at EAC as part of the Fab Lab programs. EAC and EMCC were the only colleges that offered electronics courses for their programs, but did not have a machining program.

Table 14: Program enrollment by college

Major Program Areas (Aggregated)	CAC	EAC	EMCC	GWCC	Total
CAD/drafting	0	86	0	0	86
Electronics	0	78	5	0	83
Industrial maintenance	11	7	8	0	26
Machining	3	37	0	22	62
Manufacturing technology/Engineering	1	21	6	0	28
Welding	63	121	0	27	211

On the survey participants were asked how they came to learn about the AZ RAMP UP project. The word cloud below shows the most frequently cited sources by the survey respondents. High school, friend/word-of-mouth, and online search were the most cited sources from which the participants learned about their programs. Having high schools as the most cited source validated the outreach efforts that the career navigators made to this target audience.

Figure 7: Word cloud of frequently mentioned cited sources about the program



The survey asked participants to rate their experiences with various aspects of their program on a 5-point scale (1= strongly disagree or disapprove; 5 = strongly agree or approve). Each cell in Table 14 shows the percentage of respondents who rated a program aspect with a 4 or 5. Percentages highlighted in increasing shade and intensity of blue have approval ratings below 80%. Overall, the participants gave high approval (>80%) ratings to all aspects of the program they participated in, with the exception of the participants in the "industrial maintenance" programs. Less than 70% of the participants in that program gave 4 or 5 rating to multiple aspects of their program, such as "fee structure", "laboratory", and "training in soft skills". Fee structure, in general, received the lowest ratings across all areas of study.

Through surveys and focus group discussions, participants across the programs criticized the fee structure of the programs, especially during the early years of implementation. Participants reported some confusion on what they presumed was covered by enrolling in the AZ RAMP UP program versus what the participants had to contribute out of pocket or through other means, such as the GI Bill (for veterans), or through the TAACCCT (TAA-eligible worker), or federal student loans or grants. Because these were technical programs, participants had to make out-of-pocket contributions for tools, consumable supplies, laboratory use, and web-based learning platforms.

Table 15: Approval ratings of programs by area of study

	CAD/Drafting	Electronics	Industrial Maintenance	Machining	Manufacturing Technology	Welding
Program of study	92%	96%	81%	84%	93%	88%
Registration	88%	89%	81%	81%	86%	77%
Advisement	83%	83%	69%	81%	79%	77%
Career/job prospect	79%	89%	69%	81%	82%	77%
Fee structure	79%	82%	62%	65%	75%	70%
Instruction	93%	95%	77%	84%	93%	87%
Laboratory	94%	94%	62%	85%	89%	92%
Course timing and format	87%	92%	77%	66%	86%	81%
Instructor	95%	94%	81%	87%	96%	89%

	CAD/Drafting	Electronics	Industrial Maintenance	Machining	Manufacturing Technology	Welding
Equipment	86%	95%	81%	87%	82%	94%
Training in soft skills	84%	86%	58%	74%	82%	82%
Feedback from Instructor	95%	95%	96%	90%	96%	92%
Course materials	90%	95%	77%	79%	93%	86%
N	**86**	**83**	**26**	**62**	**28**	**211**

Table below presents the program approval ratings by college. While the majority of the participants at CAC, EAC, and EMCC expressed high satisfaction with their programs, the participants at GWCC gave moderate ratings to their programs. Similar to Table 15, percentages highlighted in increasing shade and intensity of blue have approval ratings below 80%. Less than 60 percent of the participants at GWCC expressed positive experience with registration, advisement, fee structure, course timing and format, and training in soft skills.

Table 16: Approval rating of program by consortium site

	CAC	EAC	EMCC	GWCC
Program of study	85%	93%	84%	73%
Registration	79%	86%	84%	57%
Advisement	83%	82%	79%	55%
Career/Job prospect	81%	83%	68%	61%
Fee structure	62%	78%	74%	51%
Instruction	86%	94%	84%	63%
Laboratory	87%	94%	74%	78%
Course timing and format	76%	90%	74%	**41%**
Instructor	86%	96%	84%	63%
Equipment	90%	92%	89%	86%

	CAC	EAC	EMCC	GWCC
Training in soft skills	74%	85%	84%	59%
Feedback from Instructor	88%	96%	100%	80%
Course Materials	81%	91%	84%	78%
N	**70**	**351**	**19**	**49**

In general, the survey respondents were very positive about their experience with the program. Common reasons for the low approval ratings cited here included the following:

- *Computers were not good and crashed often.*
- *Conflicting class schedule.*
- *Class schedule lacked flexibility to adjust for emergency life situations.*
- *Uncertainty around classes being offered; no real welding degree map.*
- *Block scheduling was a problem for those who were employed full time.*
- *Fee structure forced paying for blocked hours and did not allow pay by hour basis for machines.*
- *Guidance and advisement services could be better.*

A probable basis for the lowered satisfaction with the programs at GWCC was the turnover of machining instructors and location changes of equipment which occurred in 2016. Block scheduling format from 6 AM to 2 PM made it difficult for participants to work and go to school part-time, much less full time. The 12-month clock hour certificate program in machining was also reportedly too long for at least one participant, which left the participant idling for nearly three months until the 12 months elapsed. Combined with an inflexible fee structure, uneven quality of instruction, and high student-to-instructor ratio, the program frustrated quite a few participants.

A change in instructors in 2017 who revamped the machining curricula and shortened the program duration to nine months greatly improved the program. The completion of the equipment re-location and the expansion of lab class hours to include evening and morning shifts had also improved student satisfaction with the program.

Participants also provided feedback on how the AZ RAMP UP project was advising and assisting participants gain employment. Table 17 presents participants' responses related to employment assistance they received from the project. More than 60% of the respondents across all colleges, except EAC, reported that they received direct assistance related to their job placements.

Due to the small sample size, no meaningful conclusions could be derived for EAC. More than 75% of the respondents also reported that their job placement was relevant to their program of study.

Table 17: Direct Employment Assistance and Job Relevance

College	N	Direct Assistance	Job Relevance
CAC	45	67%	78%
EAC	9	33%	33%
EMCC	41	61%	78%
MSC	18	72%	89%

4.8 Partnerships

One of the main features the TAACCCT grant and AZ RAMP UP project in particular was to build up relationships with businesses and industries in the region in order to align the supply of skilled workers with the demand for skilled labor. Over the last three years, but particularly in the last two years, industry partnerships grew significantly as the consortium colleges worked to build up an array of future employers for program participants but also partners in transforming the region's perceptions of advanced manufacturing, construction, and energy sectors. Table 18 summarizes the industry partnerships the colleges have developed by type and by college.

Table 18: Industry and business partnership by type and college*

		Partnership Type					Consortium Site			
Count	Industry/Business Name	College Campus Tour?	Industry/ Community Partner?	Potential/ Recruiting Employer?	Internships, Externships, or Apprenticeship?	Advisory Board?	CAC	EAC	EMCC	GWCC
1	Abbott Nutrition						✓			
2	ACO Polymer						✓			
3	Allied Machine Works		✓				✓			
4	Amazon.com		✓							✓
5	Arizona Electric Power	✓					✓			
6	Arizona Public Service		✓	✓	✓				✓	
7	Arizona@Work		✓				✓	✓	✓	✓

		Partnership Type					Consortium Site			
Count	Industry/Business Name	College Campus Tour?	Industry/ Community Partner?	Potential/ Recruiting Employer?	Internships, Externships, or Apprenticeship?	Advisory Board?	CAC	EAC	EMCC	GWCC
8	Bull Moose Tube		✓				✓			
9	Cassavant Machining			✓						✓
10	CMI	✓		✓		✓		✓		
11	Danrick Builders						✓			
12	Day & Zimmerman		✓		✓		✓		✓	
13	Diamond Plastics		✓				✓			
14	DIRTT		✓	✓						✓
15	Earp Machinery	✓		✓		✓		✓		
16	EESERV	✓			✓		✓			
17	Elite Line Services	✓		✓					✓	
18	Elrus Aggregate Systems	✓								
19	F & B Manufacturing						✓			
20	Freeport McMoran		✓	✓	✓	✓		✓		
21	Frito Lay		✓		✓		✓			
22	Goodwill		✓							✓
23	Graham Packaging						✓			
24	Holsium Bakeries				✓				✓	
25	Honeywell		✓						✓	✓
26	Intel		✓		✓				✓	
27	L&H Industries		✓						✓	✓
28	Lincoln Electric	✓					✓			
29	Lonestar Racing			✓						✓
30	LRW, Inc.	✓								✓
31	Lucid Motors		✓				✓			
32	Matheson	✓					✓			
33	MaxQ Technology		✓	✓						✓
34	Micro-Tronics						✓			
35	Modern Industries				✓			✓	✓	
36	Nesco, Inc.	✓								✓
37	Northstar Aerospace				✓					✓
38	Open Loop Energy	✓		✓		✓		✓		

		Partnership Type					Consortium Site			
Count	Industry/Business Name	College Campus Tour?	Industry/ Community Partner?	Potential/ Recruiting Employer?	Internships, Externships, or Apprenticeship?	Advisory Board?	CAC	EAC	EMCC	GWCC
39	Otto Industries	✓					✓			
40	Palo Verde Generating Station		✓	✓		✓			✓	
41	Performance Grinding				✓		✓			✓
42	Resolute Copper				✓		✓			
43	Rugo Machine	✓					✓			
44	Schuff Steel	✓		✓			✓			
45	Sheffield Lubricants		✓				✓			
46	Southwest Gas		✓						✓	✓
47	Stinger Bridge and Iron	✓					✓			
48	Sun Pumps	✓		✓		✓		✓		
49	Sundt Construction				✓		✓			
50	Suntree				✓				✓	
51	Surfcam		✓				✓			
52	Tolleson Dairy				✓				✓	
53	Trans-Matic									✓
54	Walmart Distribution Center		✓				✓			
	TOTAL	**16**	**20**	**13**	**14**	**6**	**27**	**7**	**13**	**14**

**As of May 2018*

The different types of business and industry partner engagement hint at the depth and breadth of relationship that have developed over the course of the grant. Administrators from at least one college admitted that the college once had a decades-long indifference towards businesses and industries in the area, and the quality of its programs reflected the disconnect between what the businesses and industries sought for in potential employees and the knowledge and skills of the college's graduates. Establishing or re-establishing mutual awareness of what a college-industry partnership could bring to their respective institutions was thus a critical step. College campus tours provided the colleges the opportunity to reset relationships between the institutions and showcase improvements that the colleges made. The tours also became a pre-cursor to later activities, including tours of company plants, company presentations to participants on employment opportunities at

their sites and more extensive college-industry collaborations and support. For example partnership engagement continued to evolve and grow to include apprenticeships (ex: Intel-EMCC and Freeport McMoran-EAC), donations of consumable supplies, equipment and services (ex: Daisy Brand and Cyberweld-CAC and Performance Grinding-GWCC), sponsorship of curricula and instructors (ex: Day and Zimmerman-EMCC and Sundt Construction-CAC).

On a more macro-level, representatives from Palo Verde Generating Station (PVGS) have been supportive of development of the IMET program at EMCC in relation to its long-standing engagement with EMCC's power plant technology program. PVGS saw the expansion of EMCC's programming portfolio as a way to diversify the workforce and economy in west Phoenix. A the same time, PVGS saw the IMET program as enhancing the quality of employee pool PVGS would be in the market to hire. In a similar vein, CAC's partnership with Lucid Motors on the heels of the development of PhoenixMart, a global marketplace for manufacturers, distributers, suppliers and buyers currently under construction in Pinal County, ensured the college's seat in the economic development in central Arizona.

Moreover, three of the four consortium colleges came together "to craft a collaborative, regional approach to meeting the needs of Central and Southeast Arizona's advanced manufacturing sector. This standardized approach to advanced manufacturing and precision production training across the region represents a new level of collaboration and cooperation among the region's educational institutions" (Arizona Commerce Authority, 2017). Known as the Arizona Advanced Technologies Corridor Project, the colleges united their voices in inviting the region's industries in co-developing a regional training strategy based on three questions:

1) "How many job descriptions does your organization employ?
2) Do you require or prefer a certain level of education? Industry certification?
3) What levels of education or experience do you struggle to find?" (Arizona Commerce Authority, 2017).

All the industry partnerships developed through the grant are expected to continue to grow and expand beyond the grant period. They also appeared to buttress the programs. Student supports and reduction in staffing to AZ RAMP UP programs were initially proposed due to funding cuts at CAC. Industry partners' outcry and the college president's support for the grant-funded programs helped restored funding and staffing for at least a year.

4.9 Strengths and Weaknesses of the Project

The implementation of the AZ RAMP UP project revealed several strengths of the project. It validated the project's theoretical framework and how the various evidence-based practices came

together to create a coherent system of programs. The implementation of AZ RAMP UP also highlighted the support from the industry partners. They became vital to the success and sustainability of the programs created under the project. Another area of strength was the career navigators assisting the participants throughout their time at the consortium colleges. They were instrumental in getting participants properly on-boarded by helping make sense of the enrollment and financial aid processes. Moving forward, one weakness with the project is that was still depended on career navigators for selling new programs and advanced manufacturing as a career route.

5.0 Participant Impacts and Outcomes

The overall successful implementation of a robust set of AZ RAMP UP programs roused enthusiasm among the colleges that the anticipated outcomes and impacts of the programs would be realized by the end of the grant period. There were gains in enrollment and completion over the course of four years across the AZ RAMP UP consortium colleges. As of July 2018, a total of 929 participants were enrolled and 287 were awarded a credential during the grant period. The number of participants still retained when the grant period ended was 425. A total of 146 participants, who were employed at enrollment, received a wage increase post-enrollment.

While the actual numerical results have somewhat tempered their expectations, the initial results did show that the AZ RAMP UP program would have met and in some instances exceeded expectations had current participants have more time to complete their programs and be counted in the ways that DOL had defined them. More importantly, the additional time would have ensured that the sustainability practices already underway would have taken root at the colleges and provided fuel for greater impact on the program participants, the colleges and on the economy of central and eastern Arizona as whole.

5.1 Summary of Participant Outcomes

The data analyses presented in this section were based on data as of June 2018. AZ RAMP UP's final outcome numbers will be slightly different as final reporting will incorporate all results shared on March 2018. The figures in section 5.2 may differ in totals presented earlier in this section due to the differences in data pulled in March and in June.

5.1.1 Participant Demographical Background

As iterated earlier in this report, the participants were different from the original target audience of the AZ RAMP UP project. Originally, TAA-eligible workers were main audience. Since the economic recovery, more of the participants were younger. They were more likely current or

recent high school graduates. Table 18 presents the student demographical background based latest data as of June 2018.

Table 19: Participants' Demographic Characteristics

Characteristics	CAC	EAC	EMCC	GWCC
Participants (N)	179	379	249	110
Married	22%	23%	27%	14%
Female	7%	12%	11%	5%
Race/Ethnicity				
White	68%	64%	72%	66%
Black	11%	3%	6%	5%
Other	21%	33%	22%	29%
Hispanic	35%	23%	39%	23%
Pell Eligible	54%	37%	49%	54%
Veteran	13%	8%	27%	30%

Demographic profile of the participants appeared to be consistent across four campuses. The majority of the participants were white males. CAC recruited the highest share of black participants (about 11%). About 40% of the participants at CAC and EMCC were of Hispanic origin, which was more than 10 percentage points higher than the other two locations. Half of the participants were Pell grant eligible at all colleges. GWCC and EMCC recruited highest percentage (about 30%) of veterans.

5.1.2 Comparison of Actual to Target Outcomes

Table 20 showcases actual outcomes and compares them against the target outcomes in the AZ RAMP UP project. While in eight of the nine outcomes the project fell short of its targets, in one outcome, AZ RAMP UP exceeded its target: total number of participants completing credit hours (Outcome 4). This outcome is promising since it demonstrated that far more participants were in the training pipeline and would eventually leave the programs and gain employment related to the field they trained. Moreover, AZ RAMP UP project almost met Outcome 1 by a mere 80 participants, and Outcome 3 by 256 participants.

Table 20: Actual to Target Comparison (years 1 through 4 as of June 2018)

Outcome Table	Year	CAC	EAC	EMCC	GWCC	Total	Target[12]	Status

[12] AZ RAMP UP received a no-cost extension which extended the period of accepting participants to the program through spring 2018.

Outcome Table	Year	CAC	EAC	EMCC	GWCC	Total	Target[12]	Status
1: Total unique participants served	**1**	32	58	0	0	90	148	Not met
	2	36	118	172	31	357	434	Not met
	3	76	108	33	55	272	477	Not met
	4	34	107	45	24	210	N/A	N/A
	TOTAL	**178**	**391**	**250**	**110**	**929**	**1009**	**Not met**
2: Total participants completing a TAACCCT-funded program of study	**1**	0	0	0	0	0	0	Met
	2	18	20	12	21	71	282	Not met
	3	27	17	34	40	118	381	Not met
	4	17	8	13	29	67	N/A	Not met
	TOTAL	**62**	**45**	**59**	**90**	**256**	**659**	**Not met**
3: Number of participants still retained in their program of study or other TAACCCT-funded program[13]	**1**	31	58	0	0	89	91	Not met
	2	30	116	156	8	310	259	Met
	3	57	138	109	12	316	316	Met
	4	51	232	139	3	425	N/A	N/A
	TOTAL	**51**	**232**	**139**	**3**	**425**	**681**	**Not met**
4: Total number of participants completing credit hours[11]	**1**	15	0	0	0	15	49	Not met
	2	41	126	128	0	295	121	Met
	3	74	226	145	0	445	129	Met
	4	86	96	134	0	316	N/A	N/A
	TOTAL	**216**	**448**	**407**	**0**	**1071**	**308**	**Met**
5: Total number of participants earning credentials[14]	**1**	0	0	0	0	0	0	Met
	2	11	23	13	31	78	278	Not met
	3	29	20	46	45	140	375	Not met
	4	18	9	13	29	69	N/A	N/A
	TOTAL	**58**	**52**	**72**	**105**	**287**	**654**	**Not met**
6: Total number of participants enrolled in further education[15]	**1**	0	0	0	0	0	0	Met
	2	0	1	0	0	8	47	Not met
	3	0	0	1	0	7	63	Not met
	4	0	4	0	0	6	N/A	N/A
	TOTAL	**0**	**5**	**1**	**0**	**21**	**100**	**Not met**
7: Total number of participants employed after TAACCCT-funded program of study completion	**1**	0	0	0	0	0	0	Met
	2	5	0	2	1	8	115	Not met
	3	4	0	3	0	7	115	Not met
	4	6	0	0	0	6	85	Not met
	Total	**15**	**0**	**5**	**1**	**21**	**315**	**Not met**

[13] This number is a running total. Thus there is no overall total.

[14] GWCC participants accrue clock hours and not credit hours.

[15] Completers who enrolled in further education.

Outcome Table	Year	CAC	EAC	EMCC	GWCC	Total	Target[12]	Status
8: Total number of participants retained in employment after program of study completion	**1**	0	0	0	0	0	0	Met
	2	3	0	0	0	3	103	Not met
	3	4	0	0	0	4	103	Not met
	4	4	0	0	1	5	77	Not met
	Total	**11**	**0**	**0**	**1**	**12**	**283**	**Not met**
9: Participants employed at enrollment receiving a wage increase post-enrollment	**1**	0	0	0	0	0	0	Met
	2	0	0	0	3	3	72	Not met
	3	30	1	60	11	102	124	Not met
	4	19	0	11	11	41	110	Not met
	Total	**49**	**1**	**71**	**25**	**146**	**306**	**Not met**

There were several factors that may have contributed to the large number of participants who were still in the matriculating in their respective TAACCCT-supported programs at the end of the grant period. One factor was related to the age of the participants. As noted earlier, many of the participants were young students who had limited, if any, experience in their trained field. These young participants were staying in the programs longer and earning multiple industry-endorsed credentials and credit hours (or clock hours) until they have completed their degree or certificate. At EAC some of the participants were high school students who were taking classes at the community college and earning credits as part of a dual enrollment program between their high school and the AZ RAMP UP consortium college. As dual enrolled participants, they would stay in the program until they graduated high school and completed earning the credit hours toward their AZ RAMP UP program.

Another factor pertained to the ease with which the stacked and latticed credentialing of the programs related to one another. For several programs at CAC, EMCC, and EAC credit courses for certificate programs would roll into associate degree programs or additional degree programs. For example, CAC participants pursuing an industrial maintenance certificate (18 credit hours total) or advanced industrial maintenance certificate (17 credit hours total) could earn an applied science associate's degree in manufacturing engineering technology (64 to 71 credit hours total). Or in the case of EMCC's power plant technology (PPT) and IMET program, participants enrolled in one program could earn a second associate's degree with the other after completing additional courses. Several of the participants expressed doing so to improve their marketability across both energy and industrial maintenance sectors. Thus, participants took longer to exit the consortium colleges and enter the job market with their earned credentials, certificates, and/or degrees.

DOL definitions pertaining to incumbent workers may have also undercounted the number of participants according to the outcomes listed on Table 20. DOL treats incumbent workers

differently than unemployed and underemployed workers, thus reducing the magnitude that the AZ RAMP UP programs, particularly programs at CAC, may have affected participants.

Another potential contributing factor was an unintended bureaucratic policy at CAC which artificially kept participants enrolled in programs. AZ RAMP UP project staff at CAC discovered that costs for filing the paperwork to graduate with a degree or certificate were computed based on the number of filings. As a result CAC participants waited until they had completed their program of study and bundled filing the paperwork to receive their industry-endorsed credentials as well as their certificate or degree. Since this administrative policy was discovered, CAC made policy changes to alleviate the cost burden on participants.

Finally, time was a contributing factor in maintaining a large number of participants in the programs' pipeline. Once all the programs were fully active and matriculating students, time was needed to see them through to program completion and workforce participation. The timing of the end of grant period also coincided with the largest influx of participants in the system as a result of successful publicity and outreach campaigns by the career navigators.

Sections 5.2 through 5.6 examine each of these nine outcomes further.

5.2 Project Enrollment

EAC enrolled 391 participants, the highest number of unique participants for the AZ RAMP UP programs. EAC's impressive enrollment figures were followed by those from EMCC (250 participants), CAC (178 participants), and GWCC (110 participants). Table 21 shows the total number of unique individuals participating in programs by college based on data as of June 2018.

A contributing factor to the large number of the participants enrolling at EAC was the construction of the Fab Lab and the new programs that resulted from the new facility. The Fab Lab drew many people—old and young—to take part in in advanced manufacturing courses that involved building things using new equipment like 3-D printers, programmable laser cutting and engraving machines, and integrated AutoCAD® design software. In fact, several of the EAC participants were retirees who enjoyed the opportunity to learn something new and productive using the latest technology.

Table 21: Program enrollment by AZ RAMP UP consortium college

College	TAACCCT Program Areas	Number of Participants
CAC	Manufacturing Technology, Industrial Maintenance, Machining, Electronics, Welding	178

EAC	CAD/Drafting, Manufacturing Technology, Electronics, Welding	391
EMCC	Manufacturing Technology, Industrial Maintenance, Electronics	250
GWCC	Machining, Welding	110

The following bar graphs below (see Figures 8 through 11) show the progression of total enrollment by each college from year 1 (ending in September 2015) to year 4 (ending in March 2018). Differences in numbers cited in Table 20 and the bar graphs reflected participants' enrollment in more than one program.

The highest numbers of participants were posted in the 2016-17 academic year, consistently across all four consortium colleges. Enrollment numbers for 2017-18 academic year were smaller since they reflect only a portion of the academic year, up to March 2018. EAC project staff did note that enrollment had started to slow down at the college as enthusiasm resulting from the opening of the Fab Lab began to settle down.

Figure 8: CAC program enrollments by academic year

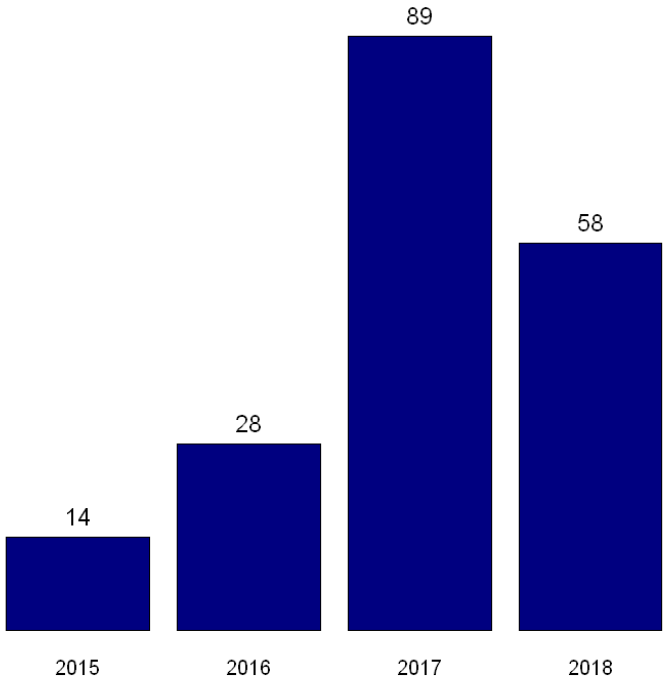


Figure 9: EAC program enrollments by academic year

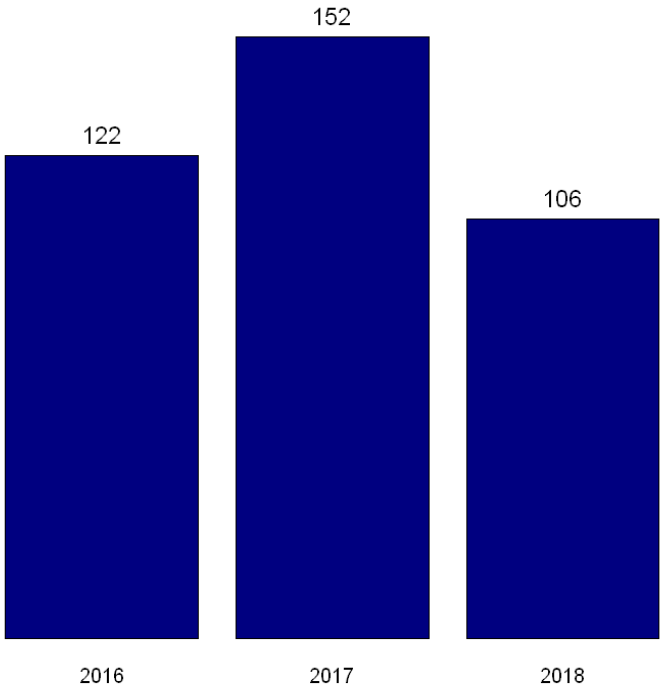


Figure 10: EMCC program enrollments by academic year

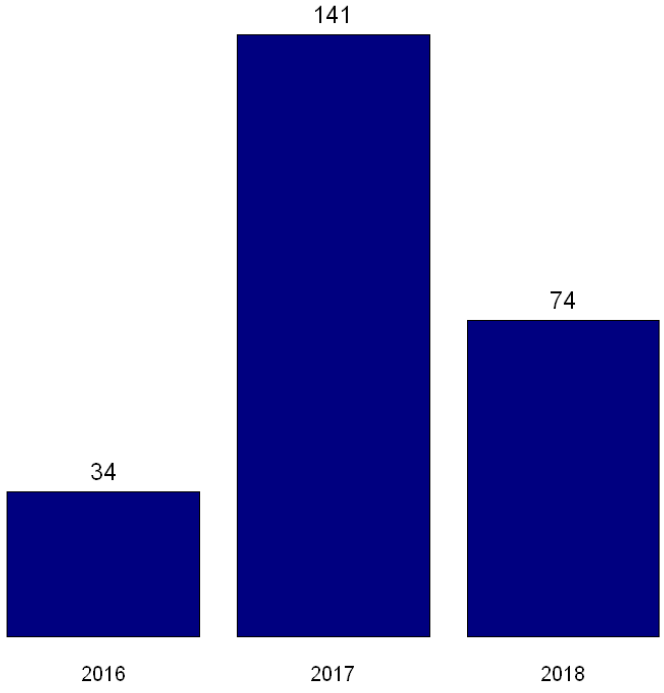
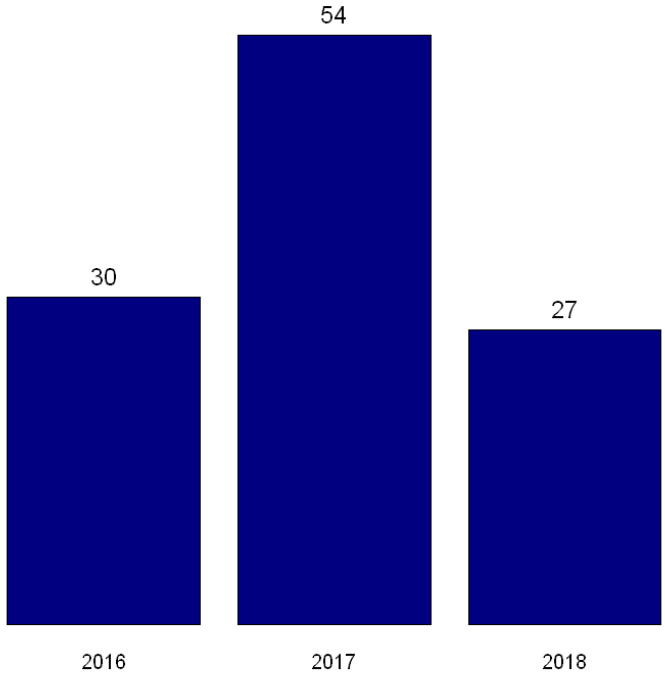


Figure 11: GWCC program enrollments by academic year



5.3 Certificate and/or Degree Completion

Below are bar graphs showing cumulative program completions over time by college. A participant may have completed more than one certificate or degree during his or her time at the college. As such, the charts show a cumulative rather than annual numbers. Figures 12 through 15 show that the number of certificate and degree completions increased consistently over time across all locations.

Figure 12: CAC cumulative certificate and/or degree completion, by academic year

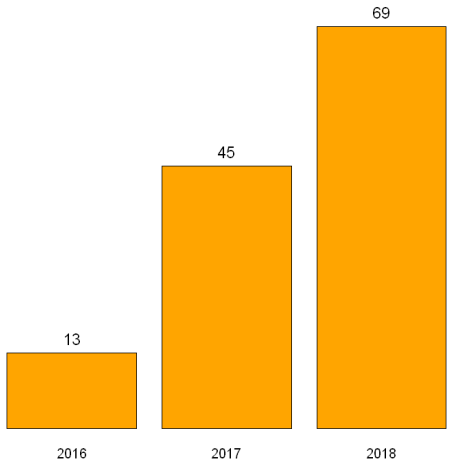


Figure 13: EAC cumulative certificate and/or degree completion, by academic year

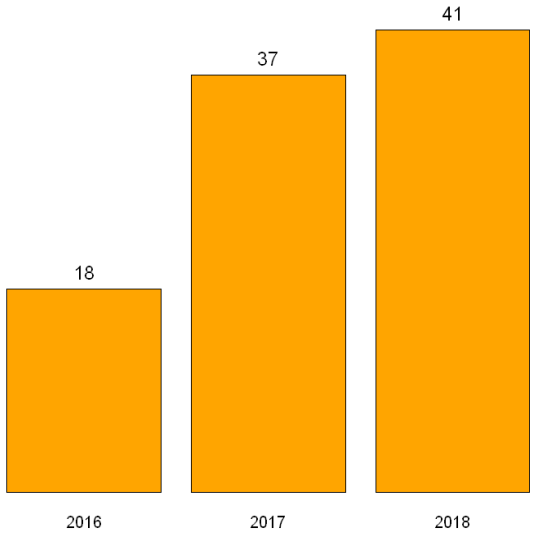


Figure 14: EMCC cumulative certificate and/or degree completion, by academic year

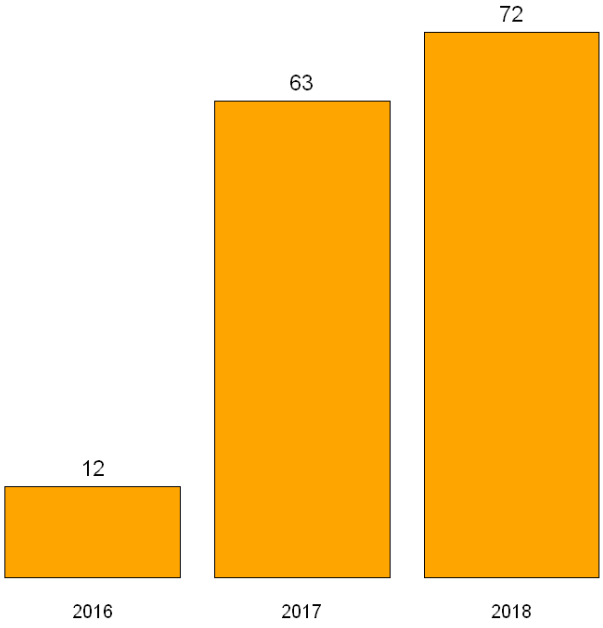
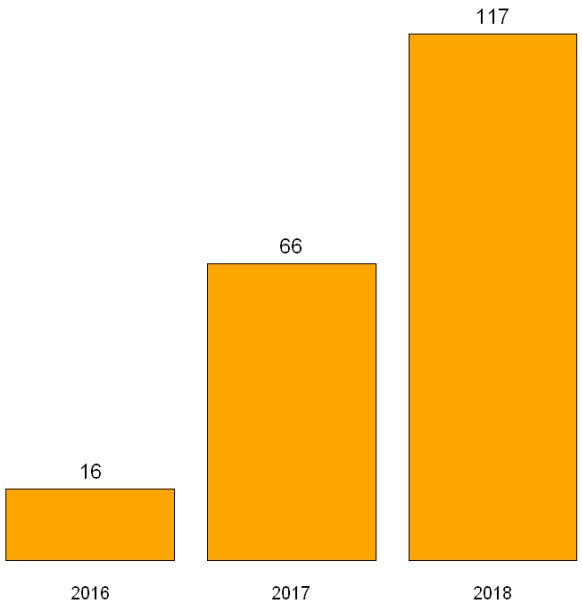


Figure 15: GWCC cumulative certificate and/or degree completion, by academic year



5.4 Time to Program Completion

One of the key outcomes for TAACCCT grants is to decrease the amount of time needed to obtain an industry-endorsed credential or complete a program. Table 22 demonstrates that AZ RAMP UP succeeded in delivering on that outcome. Overall, the length of time to completion shortened as the project matured. The average time to completion was shortest in GWCC (2.8 months), followed by CAC (5.1 months), EMCC (6.5 months), and EAC (9.7 months).

Table 22: Average time to program completion measured in months

Entering Year				
College	***2015***	***2016***	***2017***	***Overall***
CAC	9 *(16*)*	3 *(12)*	4 *(34)*	5.1 *(62)*
EAC	13 *(20)*	7 *(16)*	3 *(3)*	9.8 *(39)*
EMCC	NA *(0)*	7 *(59)*	1 *(5)*	6.5 *(64)*
GWCC	3 *(14)*	5 *(19)*	2 *(56)*	2.8 *(89)*

* The figures in parentheses represent the number of participants who completed their program. For example, 16 participants at CAC entered their program in 2015 and on average completed in 9 months.

5.5 Earned Credentials and Degrees

Table 23 shows the percentage of participants who earned at least one professional credential, a certificate or associates' degree, or was in the process of earning one. Data show that the majority of the participants across the four consortium colleges completed the requirements to earn a

professional credential or were in the process of completion. At CAC, three out of four participants earned a professional credential and 45 percent completed their degrees. At EAC, one-third earned a professional credential and 55 percent completed their degrees. At EMCC, only 16 percent earned a professional credential, but 92 percent completed or were in the process of completing their degrees. At GWCC, 83 percent earned a professional credential.

Table 23: Credentials earned or in progress

College	Avg. Credits Completed	Avg. Credits Still Enrolled	Professional Credentials or Certificate Earned/In Progress	Degree Completed/ In Progress
CAC	11.67	13.00	75%	45%
EAC	9.81	12.22	29%	55%
EMCC	9.91	10.21	16%	92%
GWCC	NA*	NA	83%	NA

* GWCC participants registered clock hours, not credit hours.

5.5.1 Credentials Earned by Pell Grant Status

Analyses were conducted to see if there were difference in credentials, certificates, and/or degrees earned based on the economic status of the participants. Participants who are eligible for Pell grants are from households that earn less than $30,000 a year. Table 24 presents credentials earned by Pell grant status. Results from the analyses show that non-eligible participants pursued professional certificates in higher proportions, whereas Pell grant-eligible participants pursued associate's degree in higher proportions.

Table 24: Credentials earned or in progress by Pell grant status

College	Professional Credential or Certificate Earned/ In Progress		Degree Completed/ In Progress	
	Pell Eligible	Not Pell Eligible	Pell Eligible	Not Pell Eligible
CAC	73%	81%	49%	42%
EAC	29%	30%	67%	49%
EMCC	17%	15%	92%	91%
GWCC*	78%	86%	NA	NA

* GWCC TAACCCT Programs confer only certificates not degrees.

5.6 Post-completion Wages

The AZ RAMP UP project also made an effort to collect and analyze participants' pre- and post-program hourly wages to determine if the project had any effect on their wages. A two-tailed paired t-test of sample means was conducted to measure the statistical significance of the program impact. To carry out this test, required having paired sample of participants who reported both pre- and post-programs wages.

The null hypothesis assumes that the difference (μ_0) between pre- and post means is equal to zero.

$$H_0: \mu_0 = 0$$
$$H_a: \mu_0 \neq 0$$

Table 25 shows average pre- and post-program wages by consortium college. Average hourly wages increased after the program completion across all campuses. Across all campuses, on average, 72% of the participants saw their wage increased after completion. At CAC, the post-program increase was found to be statistically significant at the 0.01 level.

In 2016, the latest year for which the wage data is available, the average hourly wage in the manufacturing industry in the state of Arizona is $17.60. Only EMCC participants were found to be earning higher hourly wage than the state average.

Table 25: Pre- and post-program average hourly wages

Average Hourly Wage					
College	N	Pre	Post	*p-value*	Arizona-Manufacturing Industry[16]
CAC	26	$13.78	$16.33	0.008 < 0.05	$17.60
EAC	3*	$10.38	$11.50	NA	
EMCC	***39***	***$17.93***	***$20.26***	***0.122 > 0.05***	
GWCC	11*	$14.12	$16.16	NA	

* Sample size is too small to conduct statistical test. At EAC and MSC, paired pre- and post-wages are available for very few participants.

[16] source: Arizona Labor Statistics, https://laborstats.az.gov/employment

6.0 Institutional Outcomes

Across the consortium colleges, the impact of the AZ RAMP UP project was felt in several ways. First was the presence of new equipment that was purchased through the grant. All four consortium colleges updated their facilities with new machines and renovation of facilities. AZ RAMP UP project staff, consortium college administrators, industry partners, current participants, and completers all cited the new equipment as a draw to the colleges and to the programs. These new machines were critical in providing participants training in the actual machines they would see and use in the workplace. AZ RAMP UP project staff and consortium college administrators also reported that purchasing the new equipment would have been challenging without the grant.

In only one area did the investment in new technologies yield underwhelming results: current employers around the CAC region still relied on manual machining for their work. CAC was ahead of the curve with CNC machining. CAC had to adjust their curriculum to include both manual and CNC machining to ensure that completers of the machining program have the marketable competencies that the current employers seek. In the future, when employers also upgrade their equipment and facilities, the program—and program completers—will be well positioned to take on filling the positions associated with CNC machining.

A second outcome has been the new and enhanced programs that would not have existed without the TAACCCT grant. The grant provided initial investment for new equipment, new curricula, and staff. Moreover, the grant prompted better linkages and collaboration across the technical programs in the consortium. CAC and EAC instructors and site coordinators reported that the shared courses, courses that cut across multiple programs, have helped participants see how knowledge and skills gained in these shared courses point to different yet similar industries. The shared coursework also helped the instructors and coordinators streamline the curricula to be more responsive to industry needs.

A third positive outcome was the revitalization of partnership and collaboration with businesses and industry in the region. The TAACCCT grant prompted the consortium colleges to work more closely with the business and industry sector, to the benefit of both ends of the workforce development pipeline, particularly the colleges. The colleges gained materially through

1) donations of supplies, equipment and services (e.g., sponsorship of online credentialing platform);
2) human capital through internships, apprenticeships and instructors; and
3) social capital through contacts, networks and relationships with individuals associated with the industry partners that build up the colleges' contribution to the economy of the region.

Last but not least, the TAACCCT grant contributed to increased enrollment at the consortium colleges. CAC, EAC, and GWCC's welding programs have seen increased enrollment that was at or well above capacity. The high enrollment has already prompted GWCC to expand its welding labs to meet the demand for more skills training. For EAC, the TAACCCT grant positively impacted enrollment across most of its technical programs as a result of AZ RAMP UP. Table 26 shows the enrollment trends before and during the AZ RAMP UP project for EAC's technical programs. The exception is the automotive program. Yellow-highlighted areas reflect the period since the AZ RAMP UP project.

Table 26: EAC enrollment by technical program

	Technical Programs (With Duplicated Enrollment)						
Fiscal Year	Auto	Drafting	Electrical	Engineering	Machine Shop	Welding	Advanced Manufacturing
2012	312	198	118	91	59	281	0
2013	283	208	275	67	68	317	0
2014	236	257	186	71	100	289	0
2015	275	241	103	56	73	248	0
2016	241	269	114	89	53	301	90
2017	193	281	185	83	68	327	129

7.0 Regional Outcomes

One of the challenges facing the manufacturing industry has been an aging workforce while at the same time skilled labor is in high demand. "There are manufacturing jobs available right now, but young people have moved on. An entire generation of Americans has forgotten about manufacturing as a career path," Scott Paul remarked president the Alliance for American Manufacturing (Long & Van Dam, 2018). The AZ RAMP UP project provided a set of strategies for other colleges to cultivate interest among teenagers, middle schoolers, and their parents at large. One mentioned earlier under the Partnership section was that all the consortium colleges hosted a Manufacturing Day event annually. These events drew a wider public and served to educate and recruit potential students and workers to this vibrant job and career sector.

Another strategy was dual enrollment agreements with nearby high schools. Three of the colleges, CAC, EAC, and EMCC, had dual enrollment agreements with their respective nearby high schools.[17] Thus high school students can earn their high school diploma and a certificate or associate's degree in programs supported by the AZ RAMP UP project at the concurrently. In addition, EMCC is also co-located with the Southwest Campus of West-MEC, "a public school district dedicated to providing innovative career and technical education (CTE) program that prepare students entering the workforce and pursuing continuing education" (West-MEC, n.d.). Thus high school graduates who completed their program at West-MEC could seamlessly continue their education in the same facility and with the same instructors.

A third strategy was enrichment programs targeting high school students and middle school students. CAC has hosted the Welders Without Borders Welding Thunder© TM SM Welding Fabrication Team Invitational. In the annual competition, teams of high school students or college students compete to design, build and test run a product created in a set period of time. Prior project includes a movable barbecue grill and a go-cart.

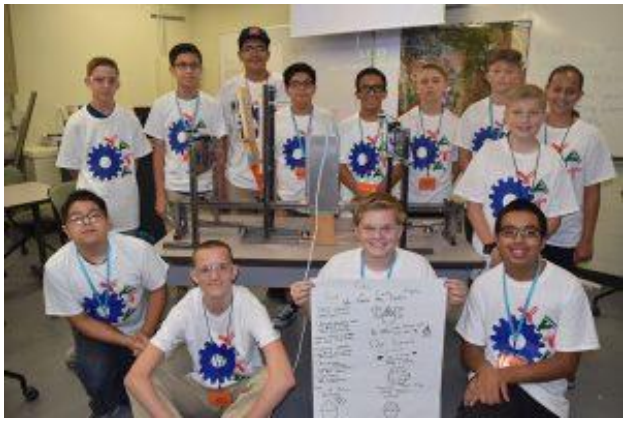
Figure 19: CAC Welding Thunder competition

[17] CAC recently established dual enrollment agreements with Coolidge High School to add to its existing agreement with Florence High School. EAC was one of the campus sites for the Gila Institute for Technology (GIFT, http://www.gift-tech.org/Central-Campus) with many GIFT students attending AZ RAMP UP grant-funded programs

Figure 20: Go-cart designed and built by CAC student welding team

For two consecutive years CAC hosted the Young Advanced Technology Academy (YATA). The academy—funded by Pinal County and developed by industry partners—engaged rising students in grades 7 through 10 to develop their advanced manufacturing skills through hand-on project-based learning. Among the skills students learn through the academy were construction, welding, manufacturing, machining and 3-D printing.[18] These early-exposure activities have shown that jobs in advanced manufacturing can be productive, fun, and satisfying professions and were no longer the "dirty jobs that their fathers and grandfathers knew. A total of 106 students participated in YATA in summer 2017 and summer 2018. YATA combined with the high school activities helped extend a guided career pathway and pipeline into the middle school and high school years.

Figure 21: Young Advanced Manufacturing Academy at CAC



[18] For more information see https://centralaz.edu/news-announcements/young-advanced-technology-academy-to-be-held-at-central-arizona-college-in-june/

8.0 Key Takeaways & Lessons Learned

Looking back at the both implementation and perceived impact of the AZ RAMP UP project, the project staff shared similar key takeaways or successes. Among the key takeaways/successes were

5) **upgraded state-of-the-art facilities with commensurate revised curriculum and instruction** – As mentioned earlier, the new machines and updated facilities created a buzz that drove interest and enrollment into the AZ RAMP UP programs.

6) **greater collaboration across the region** – greater collaboration among businesses colleges and communities as a result of both required TAACCCT activities as well as natural-occurring engagement spurred synergy at both the individual and corporate levels. Even within the colleges witnessed improved collaboration across departments. Besides those within the technical education programs, CAC saw greater collaboration between the career and technical department and the science and math department. The two departments corroborated to launch a Fab Lab housed in the science and math department.

7) **successful job placement of completers in their trained fields** – All the career navigators measured their success by the impact they were making to an individual's life trajectory. At the end of the day success was defined as securing a job in the chosen field. Those who sought help from the career navigators all found work.

8) **the presence of career navigators who provided the human touch in the "hi-tech, hi-touch, hi-impact" approach AZ RAMP UP was designed to be** – Particularly for CAC, and GWCC, the career navigators were instrumental in guiding participants through the initial maze of college bureaucracy and to keep the participants on track towards their certificate/degree attainment and job placement.

Analyses of data collected over the grant period provided some additional insights:

1) **solid theoretical framework as the basis for the project** – The underpinnings of the AZ RAMP UP project was solidly grounded on evidenced-based practices or well-documented best practices. The project's design leverage those practices to create a coherent, logical set of strategies that flow to achievable and measurable outputs and outcomes.

2) **site-based diversification and specialization in career navigation and outreach roles** – Each consortium college saw the position of career navigator and business/industry partner outreach specialist evolve over time and in some cases, became a shared responsibility with

other program and institutional staff. The division of labor depended upon the 1) level of student support services already available for participants through existing infrastructure and personnel at a site, 2) the needs of current and incoming students for personalized support, and 3) the demand to establish and grow relationships with local businesses.

3) **instructors as turn-key points in transforming unspecified interests into program enrollment, completion and job placement** – Across all the colleges, instructors played a critical role in the success and sustainability of the program. They were gatekeepers to the industry through their content expertise, connections, experience, industry contacts and through their instructional pedagogy that brings the working world into the classroom.

4) **growth in energy and construction sectors drove much of enrollment and completion** – Due to geography and a growing economy, welding programs at CAC, EAC, and GWCC were all strong, and were positioned to be self-sustaining beyond the grant. Likewise, energy-related industries (mining and power generation) have helped programs in machining, welding, and industrial maintenance at EAC and EMCC.

5) **varying degrees of program sustainability** – some programs were already sustainable by the end of the grant while others may be approaching sustainability. The degree in variation rested on at least three factors: 1) the degree or certificate program's current enrollment trends, 2) the degree of alignment between the program and current and near future employment demands in the surrounding community, and 3) institutional financial support for the maintenance of both human (faculty) and physical assets (i.e., facilities and equipment) over time. Welding and power plant technology both required considerable credentialing for employment, thus boosting the value of certificate and degree attainment in those fields. On the other hand, machining, industrial maintenance, and electronics and manufacturing technology's embrace of degrees and credentials remain tentative.

From a project management perspective, "getting back on track" was considered a success after an anemic start in Year 1 and significant personnel turnover in the years 1 and 2 of the grant. For smaller colleges like CAC and EAC, the project had positively impacted the enrollment into their industrial technology and manufacturing programs specifically, and their overall enrollment generally. It also raised the profile of their institutions considerably. CAC and EAC administrators reported garnering regional, statewide, and even national attention.

Over the course of grant, the project staff also learned some hard lessons. One of which was **"having the right people, at the right place, at the right time."** Three of the four consortium colleges floundered because of staff turnover very early in the project's timeline, which

disrupted their implementation of the project for a period. At one point the disruptions affected the entire grant when the regional project director position underwent transition for almost two years. The one consortium college that maintained the same staff throughout the project, EAC, was also the one that had the highest enrollment. EAC also had matching funds for the construction of the Fab Lab, which helped EAC keep its timetable while all the necessary amendments and approvals worked their way in the colleges' respective college bureaucracies and DOL grant administration practices.

Moreover, with renovation and construction an integral part of the AZ RAMP UP project, having a dedicated project manager overseeing the renovations, particularly CAC's building facilities and equipment acquisition would have greatly helped get the college's programs up and running sooner. Other program and instructional staff wished that there was more timely, careful and inclusive vetting of outside contractors and vendors. Problems associated with mapping curricula to desired competencies, modularizing curricula, and database management systems would have been alleviated had the contractors been selected carefully and were quickly included in the implementation process early. Even the third-party evaluator was selected and brought on board much later in the process.

Second, **AZ RAMP UP project staff must be flexible to change.** The project staff learned to adjust their approaches toward publicity, outreach and recruitment because their assumptions of who their target audience was no longer valid. Instead of TAA-eligible workers, they had to promote the programs to young adults, with some who were barely out of high school or were still in high school. Flexibility was also a necessary trait as programs were revised or tweaked based on feedback from business industry partners, participants and completers.

Third, **inertia from institutional bureaucracies was often underestimated.** AZ RAMP UP faced considerable bureaucratic challenges that tended to slow or prevent implementation, as exhibited by GWCC's challenge to reconcile clock and credit hours in order for completers of their programs to transfer their earned hours to other institutions. The AZ RAMP UP project had to learn how to navigate complex layers of bureaucracy within each college, as a consortium, and as grantees of a program overseen by a remote federal agency.

Fourth, **conducting rigorous, comparative evaluation studies required robust data sets that most colleges do not have or faced considerable difficulty to acquire.** Even colleges that received an earlier round of TAACCCT grants did not have complete data sets of pre- and post-program wage data. Robust and complete data sets were needed to provide more definitive insight as to how programs were impacting participants, colleges, and the region.

Last but not least, **political and economic conditions will continue to change and affect the trajectory of the AZ RAMP UP programs.** Already, cuts in state funding for the community colleges threatened to cut positions and services that contributed to the success of at least one of the community colleges. The president of the community college and the industry partners intervened and against prior recommendations reinstated the position of the career navigator to serve all the technical programs and restored funding for one AZ RAMP UP program with low enrollment to continue for one more year.

9.0 Conclusions & Implications for Policy and Practice

In summary AZ RAMP UP project met or partially met all of its activities and deliverables as stipulated in its proposal. Results from impact data collected show

- more than 75% of the participants either earned a degree or professional credential or were in the process of completing their degree;
- at the time of March 2018 reporting, 260 participants were still in the program – CAC (35), EAC (115), and EMCC (110);
- hourly wage increased by about $2 on average after the program completion. At least 70 percent of the participants saw their wages increased after completion;
- more than 60% of the participants found employment after program completion through direct assistance from their schools; and
- more than 70% of the participants found employment relevant to their program area.

One of the challenges in reporting on the impact of the project was the dearth of wage data available from the participants. Other TAACCCT grants have expressed a similar challenge. One of the next steps for studying approaches and strategies tested under the AZ RAMP UP project is finding innovative approaches to collecting wage data consistently and efficiently across participants and non-participants. More wage data can shed light on which occupations on average earn more and if further education through a bachelor's degree in applied science provides a substantial net gain in wage earnings against deferred income and student debt.

Higher education institutions interested in replicating the AZ RAMP UP project are advised to invest time and effort in the theoretical underpinnings of the proposed project and to devise a well-crafted logic model and work plan based on evidence-based practices. Moreover, institutions should also examine closely their proposed personnel and their ability to see the project through. As shown in this report, the linchpin to the success or hardship of the project rests on the leadership of key personnel on the project.

Federal and state policymakers interested in scaling up the best practices of AZ RAMP UP, should keep in mind how public funding of higher education can help foster economic growth. Through public-private partnerships among higher education institutions and industry partners, policymakers can address the workforce development equation in the economy. Moreover, policymakers can help higher education institutions become better agencies for growing human and social capital by encouraging and investing with the institutions' data collection and tracking on how students are doing after graduating from their programs. Already, states have statewide longitudinal data systems (SLDS) at the preK-12 level. SLDS has been extended through the Student Data Warehouse[19] (graduation, degree and wage data can be integrated into the system over time. Another state example is Missouri. The state saw Rounds 1 through 4 grant awards go to several of its colleges. Leveraging the consecutive grant funding and projects' designs resulted in the development of a robust statewide workforce development data warehouse with wage data (Busick-Drinkard, 2018).

[19] http://studentdatawarehouse.com/

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11.0 Appendix

Glossary

CAC	Central Arizona College
EAC	Eastern Arizona College
EMCC	Estrella Mountain Community College; was formerly referring specifically to the SouthWest Skill Center
GWCC	GateWay Community College-Central City; was formerly referring specifically to the Maricopa Skill Center
TAA	Trade Adjustment Assistance
TAACCCT	Trade Adjustment Assistance Community College and Career Training

Select Pictures from Consortium Member Sites

Sample equipment provided by AZ RAMP UP grant funds and
sample assignments from use of equipment


EASTERN
ARIZONA
COLLEGE


GateWay
Community College
FUCELLO ARCHITECTS


HAAS
VF 2
EXIT

Technical Details
Multivariate Matching with Automated Balance Optimization of TAACCCT Observational Student Data Using Genetic Search Algorithm

Central Arizona College

1. Introduction

In this project, we apply Genetic Matching,[20] a method of multivariate matching, which uses an evolutionary search algorithm to improve covariate balance.

Matching is being increasingly applied as a method of causal inference in many fields, including education and labor market studies. However, when we use matching methods to estimate treatment effects, the central problem relates to deciding how best to perform the matching. There is no consensus on how exactly matching ought to be done and how to measure the success of the matching procedure. Two common approaches are propensity score matching and multivariate matching based on Mahalanobis distance.[21] These methods have appealing theoretical properties if covariates have distributions such as the normal or *t*. If covariates are so distributed, the methods have the property of "equal percent bias reduction (EPBR)". When this property holds, matching will reduce bias in all linear combination of the covariates. However, a misspecified propensity score model may increase the imbalance of some observed variables post-matching, especially if the covariates have non-normal distribution,[22] or in other words, if EPBR property does not hold. In general, under such circumstances, matching will increase the bias of some linear functions of the covariates even if all univariate means are closer to the matched data than the unmatched. Unfortunately, EPBR property rarely holds with real data.

Furthermore, building a propensity score model is an iterative process, in which many candidate models are estimated and sequentially learned from one specification to the next. Hence the process of iteratively modifying the propensity score to maximize balance is often challenging. Our adopted method, Genetic Matching, eliminates the need to manually and iteratively check the propensity score. It uses a search algorithm to iteratively check and improve covariate balance automatically, and it is a generalization of propensity score and Mahalanobis Distance matching methods. It is a multivariate matching method that uses an evolutionary search algorithm developed by Mebane and Sekhon (1998[23]; Sekhon and Mebane, 1998[24]) to maximize the balance of observed covariates across

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[20] Diamond, A., and J. S. Sekhon (2012). "Genetic Matching for Estimating Causal Effects: A General Multivariate Matching Method for Achieving Balance in Observational Studies." *Review of Economics and Statistics,* 95(3): 932-945.

[21] Rosenbaum, P. R., and D. B. Rubin (1985). "Constructing a Control Group Using Multivariate Matched Sampling Methods that Incorporate the Propensity Score." *The American Statistician,* 39(1): 33-38.

[22] Diamond, A., and J. S. Sekhon (2012).

[23] Mebane, W. R. Jr., and J. S. Sekhon (1998). "GENetic Optimization Using Derivatives (GENOUD)." Software Package. http://sekhon.berkeley.edu/rgenoud/

matched treated and control units. The genetic algorithm optimizes the balance as much as possible, given the data. The method is nonparametric and does not depend on knowing or estimating the propensity score.

The algorithm has shown better properties than the usual alternative matching methods both when the EPBR property holds and when it does not.[25] In both cases, the method has demonstrated superior performance in terms of the reduction of bias and mean squared error (MSE) – in finite samples. The only limitation of this method is that it is computationally intensive and consumes significant computer running time. Nevertheless, in the expense of computer time, it dominates the other matching methods in terms of MSE when assumptions required for EPBR hold and when they do not.

2. Matching between Control and Treatment Groups

This section presents the results of matching between the control and treatment groups.

In consistent with best practice, we match with replacement, which means that one treated observation matches more than one control observation. Therefore, the matched dataset includes multiple matched control observations and we weight the matched control data to reflect the multiple matches. The sum of the weighted control observations is still equal to the original number of observations.

We have employed Genetic Matching technique in this analysis using "Matching" package[26] in R statistical computing software.

2.1. Balance Statistics

Original number of controls	290
Original number of treated	178
Matched number of observations	178
Matched number of observations (unweighted)	2420

Table 2.1 provides a summary of balance statistics for both before and after matching to check if the results from matching have actually achieved balance on a set of covariates. We found that balance between controls and treated was improved for most student characteristics after matching. Detailed program output is presented in the Appendix.

Table 2.1 Summary of Balance Statistics

	Before Matching	After Matching

[24] Sekhon, J. S. and W. R. Mebane, Jr. (1998)."Genetic Optimization Using Derivatives: Theory and Application to Nonlinear Models." *Political Analysis,* 7: 189-203.

[25] Diamond, A., and J. S. Sekhon (2012).

[26] https://cran.r-project.org/web/packages/Matching/index.html

Variable – Race/Ethnicity (American Indian and Alaskan Native)		
Mean Treatment	0.067416	0.067416
Mean Control	0.012759	0.067416
Variable – Race/Ethnicity (Black)		
Mean Treatment	0.050562	0.050562
Mean Control	0.031034	0.044944
Variable - Race/Ethnicity (Native Hawaiian or Other Pacific Islander)		
Mean Treatment	0.016854	0.016854
Mean Control	0.0068966	0.005618
Variable - Multi-Race		
Mean Treatment	0.073034	0.073034
Mean Control	0.024138	0.073034
Variable – White		
Mean Treatment	0.68539	0.68539
Mean Control	0.51379	0.69663
Variable – Full-Time		
Mean Treatment	0.84831	0.84831
Mean Control	0.37586	0.84270
Variable – Pell Eligible		
Mean Treatment	0.55618	0.55618
Mean Control	0.48276	0.55618
Variable – Veteran		
Mean Treatment	0.12921	0.12921
Mean Control	0.089655	0.11798
Interaction Variable – White × Full-Time		
Mean Treatment	0.58427	0.58427
Mean Control	0.17586	0.59551
Interaction Variable – Am. In × Full-Time		
Mean Treatment	0.044944	0.044944
Mean Control	0.065517	0.044944
Interaction Variable – White × Pell		
Mean Treatment	0.34831	0.34831
Mean Control	0.2	0.34831
Interaction Variable – Am. In × Pell		
Mean Treatment	0.033708	0.033708
Mean Control	0.096552	0.033708
Interaction Variable – Veteran × Pell		
Mean Treatment	0.073034	0.073034
Mean Control	0.048276	0.061798

Interaction Variable – Veteran × Full-Time		
Mean Treatment	0.11798	0.11798
Mean Control	0.051724	0.10674
Interaction Variable – Full-Time × Pell		
Mean Treatment	0.5	0.5
Mean Control	0.23793	0.5

The balance of each variable can be judged by several matching statistics – such as absolute mean difference, standardized mean difference, mean difference in the empirical-QQ plot between the treatment and control. After matching the magnitude of these statistics are significantly reduced. Whether the mean difference in the empirical-QQ plot is statistically significant is indicated by paired *t*- and KS-stats which test for significant difference across the entire distribution. Other KS test statistics also indicate similar results. Note that KS statistics are not relevant for indicator (dummy) variables, such as female, race/ethnicity etc.

```
************************    OUTPUT    ******************************

***** (V1) American.Indian.or.Alaskan.Native *****
                        Before Matching        After Matching
mean treatment........    0.067416          0.067416
mean control..........     0.12759          0.067416
std mean diff.........      -23.93                 0

mean raw eQQ diff.....    0.061798                 0
med  raw eQQ diff.....           0                 0
max  raw eQQ diff.....           1                 0

mean eCDF diff........    0.030085                 0
med  eCDF diff........    0.030085                 0
max  eCDF diff........     0.06017                 0

var ratio (Tr/Co).....     0.56607                 1
T-test p-value........    0.027514                 1


***** (V2) Asian *****
                        Before Matching        After Matching
mean treatment........           0                 0
mean control..........   0.0034483                 0
std mean diff.........        -Inf                 0

mean raw eQQ diff.....    0.005618                 0
med  raw eQQ diff.....           0                 0
max  raw eQQ diff.....           1                 0

mean eCDF diff........   0.0017241                 0
med  eCDF diff........   0.0017241                 0
max  eCDF diff........   0.0034483                 0

var ratio (Tr/Co).....           0               NaN
T-test p-value........     0.31815                 1


***** (V3) Black *****
                        Before Matching        After Matching
mean treatment........    0.050562          0.050562
```


```
mean control.....   0.031034         0.044944
std mean diff.....     8.8874           2.5569

mean raw eQQ diff.....   0.022472       0.00066578
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                1

mean eCDF diff.....  0.0097637       0.00033289
med  eCDF diff.....  0.0097637       0.00033289
max  eCDF diff.....   0.019527       0.00066578

var ratio (Tr/Co).....     1.5999           1.1184
T-test p-value.....    0.31423          0.31732


***** (V4) Hispanic *****
                       Before Matching        After Matching
mean treatment.....                  0                     0
mean control.....              0.20345                     0
std mean diff.....                -Inf                     0

mean raw eQQ diff.....         0.20225                     0
med  raw eQQ diff.....                0                     0
max  raw eQQ diff.....                1                     0

mean eCDF diff.....            0.10172                     0
med  eCDF diff.....            0.10172                     0
max  eCDF diff.....            0.20345                     0

var ratio (Tr/Co).....                0                   NaN
T-test p-value..... 4.4409e-16                     1


***** (V5) Native.Hawaiian.or.Other.Pacific.Islander *****
                       Before Matching        After Matching
mean treatment.....          0.016854              0.016854
mean control.....           0.0068966              0.005618
std mean diff.....             7.7137                8.7042

mean raw eQQ diff.....   0.011236        0.0026631
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                1

mean eCDF diff.....  0.0049787        0.0013316
med  eCDF diff.....  0.0049787        0.0013316
max  eCDF diff.....  0.0099574        0.0026631

var ratio (Tr/Co).....     2.4246           2.9661
T-test p-value.....    0.35875          0.15672


***** (V6) Two.or.More.Races *****
                       Before Matching        After Matching
mean treatment.....          0.073034              0.073034
mean control.....            0.024138              0.073034
std mean diff.....             18.739                     0

mean raw eQQ diff.....   0.050562                     0
med  raw eQQ diff.....          0                     0
max  raw eQQ diff.....          1                     0

mean eCDF diff.....      0.024448                     0
med  eCDF diff.....      0.024448                     0
max  eCDF diff.....      0.048896                     0

var ratio (Tr/Co).....     2.8804                     1
T-test p-value.....     0.024051                     1
```


```
***** (V7) White *****
                        Before Matching        After Matching
mean treatment........    0.68539          0.68539
mean control..........    0.51379          0.69663
std mean diff.........      36.85          -2.4129

mean raw eQQ diff.....    0.17416        0.0013316
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                1

mean eCDF diff........     0.0858       0.00066578
med  eCDF diff........     0.0858       0.00066578
max  eCDF diff........     0.1716        0.0013316

var ratio (Tr/Co).....    0.86506          1.0203
T-test p-value........ 0.00019542          0.15672


***** (V8) FT *****
                        Before Matching        After Matching
mean treatment........    0.84831          0.84831
mean control..........    0.37586           0.8427
std mean diff.........     131.34           1.5617

mean raw eQQ diff.....    0.47191       0.00066578
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                1

mean eCDF diff........    0.23623       0.00033289
med  eCDF diff........    0.23623       0.00033289
max  eCDF diff........    0.47245       0.00066578

var ratio (Tr/Co).....    0.54972          0.97071
T-test p-value........ < 2.22e-16          0.31732


***** (V9) Pell *****
                        Before Matching        After Matching
mean treatment........    0.55618          0.55618
mean control..........    0.48276          0.55618
std mean diff.........     14.736                0

mean raw eQQ diff.....   0.073034                0
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                0

mean eCDF diff........   0.036711                0
med  eCDF diff........   0.036711                0
max  eCDF diff........   0.073421                0

var ratio (Tr/Co).....    0.99071                1
T-test p-value........    0.12321                1


***** (V10) Vet *****
                        Before Matching        After Matching
mean treatment........    0.12921          0.12921
mean control..........   0.089655          0.11798
std mean diff.........      11.76           3.3402

mean raw eQQ diff.....   0.039326        0.0013316
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                1

mean eCDF diff........   0.019779       0.00066578
```


```
med  eCDF diff........   0.019779       0.00066578
max  eCDF diff........   0.039558        0.0013316

var ratio (Tr/Co).....     1.3816           1.0813
T-test p-value........    0.19262          0.15672


***** (V11) I(White * FT) *****
                        Before Matching        After Matching
mean treatment........    0.58427          0.58427
mean control..........    0.17586          0.59551
std mean diff.........     82.634          -2.2734

mean raw eQQ diff.....    0.41011        0.0013316
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                1

mean eCDF diff........     0.2042       0.00066578
med  eCDF diff........     0.2042       0.00066578
max  eCDF diff........    0.40841        0.0013316

var ratio (Tr/Co).....     1.6796           1.0084
T-test p-value........ < 2.22e-16          0.15672


***** (V12) I(Hispanic * FT) *****
                        Before Matching        After Matching
mean treatment........          0                0
mean control..........   0.065517                0
std mean diff.........       -Inf                0

mean raw eQQ diff.....   0.067416                0
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                0

mean eCDF diff........   0.032759                0
med  eCDF diff........   0.032759                0
max  eCDF diff........   0.065517                0

var ratio (Tr/Co).....          0              NaN
T-test p-value........ 9.8022e-06                1


***** (V13) I(American.Indian.or.Alaskan.Native * FT) *****
                        Before Matching        After Matching
mean treatment........   0.044944         0.044944
mean control..........   0.065517         0.044944
std mean diff.........    -9.9022                0

mean raw eQQ diff.....   0.022472                0
med  raw eQQ diff.....          0                0
max  raw eQQ diff.....          1                0

mean eCDF diff........   0.010287                0
med  eCDF diff........   0.010287                0
max  eCDF diff........   0.020573                0

var ratio (Tr/Co).....    0.70262                1
T-test p-value........    0.33501                1


***** (V14) I(White * Pell) *****
                        Before Matching        After Matching
mean treatment........    0.34831          0.34831
mean control..........        0.2          0.34831
std mean diff.........     31.042                0
```


```
mean raw eQQ diff.....    0.15169              0
med  raw eQQ diff.....          0              0
max  raw eQQ diff.....          1              0

mean eCDF diff........   0.074157              0
med  eCDF diff........   0.074157              0
max  eCDF diff........    0.14831              0

var ratio (Tr/Co).....     1.4218              1
T-test p-value........ 0.00060926              1


***** (V15) I(Hispanic * Pell) *****
                       Before Matching        After Matching
mean treatment........          0                 0
mean control..........   0.096552                 0
std mean diff.........       -Inf                 0

mean raw eQQ diff.....   0.095506                 0
med  raw eQQ diff.....          0                 0
max  raw eQQ diff.....          1                 0

mean eCDF diff........   0.048276                 0
med  eCDF diff........   0.048276                 0
max  eCDF diff........   0.096552                 0

var ratio (Tr/Co).....          0               NaN
T-test p-value........ 6.2197e-08                 1


***** (V16) I(American.Indian.or.Alaskan.Native * Pell) *****
                       Before Matching        After Matching
mean treatment........   0.033708          0.033708
mean control..........   0.096552          0.033708
std mean diff.........    -34.723                 0

mean raw eQQ diff.....   0.061798                 0
med  raw eQQ diff.....          0                 0
max  raw eQQ diff.....          1                 0

mean eCDF diff........   0.031422                 0
med  eCDF diff........   0.031422                 0
max  eCDF diff........   0.062844                 0

var ratio (Tr/Co).....    0.37422                 1
T-test p-value........  0.0045504                 1


***** (V17) I(Vet * Pell) *****
                       Before Matching        After Matching
mean treatment........   0.073034          0.073034
mean control..........   0.048276          0.061798
std mean diff.........     9.4885            4.3062

mean raw eQQ diff.....    0.02809         0.0013316
med  raw eQQ diff.....          0                 0
max  raw eQQ diff.....          1                 1

mean eCDF diff........   0.012379        0.00066578
med  eCDF diff........   0.012379        0.00066578
max  eCDF diff........   0.024758         0.0013316

var ratio (Tr/Co).....     1.4767            1.1677
T-test p-value........    0.28814           0.15672


***** (V18) I(Vet * FT) *****
```


	Before Matching	After Matching
mean treatment.....	0.11798	0.11798
mean control.....	0.051724	0.10674
std mean diff.....	20.481	3.4733
mean raw eQQ diff.....	0.067416	0.0013316
med raw eQQ diff.....	0	0
max raw eQQ diff.....	1	1
mean eCDF diff.....	0.033127	0.00066578
med eCDF diff.....	0.033127	0.00066578
max eCDF diff.....	0.066253	0.0013316
var ratio (Tr/Co).....	2.1262	1.0914
T-test p-value.....	0.016731	0.15672

***** (V19) I(Pell * FT) *****

	Before Matching	After Matching
mean treatment.....	0.5	0.5
mean control.....	0.23793	0.5
std mean diff.....	52.266	0
mean raw eQQ diff.....	0.26404	0
med raw eQQ diff.....	0	0
max raw eQQ diff.....	1	0
mean eCDF diff.....	0.13103	0
med eCDF diff.....	0.13103	0
max eCDF diff.....	0.26207	0
var ratio (Tr/Co).....	1.3818	1
T-test p-value.....	1.5344e-08	1

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