The Transformation of Energy Programming Through the Colorado Online Energy Training Consortium

Observations, Findings, and Student Outcomes

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INTRODUCTION

The Colorado Online Energy Training Consortium (COETC),[1] a United States Department of Labor (USDOL) Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant-funded project, had two primary goals. The first was to enhance energy-related programming in the state through the transformation of curricula into more accessible formats using technology and mobile learning labs. The second was a complete redesign of the developmental education (DE) pathways in the state. Colorado received this $17.3 million grant in 2011. The project ended with its fourth and final year on September 30, 2015, under a no-cost extension from the USDOL.

The COETC consortium in respect to the developmental education (DE) redesign included all thirteen community colleges in the Colorado Community College System (CCCS): Arapahoe Community College (ACC), Colorado Northwestern Community College (CNCC), Community College of Aurora (CCA), Community College of Denver (CCD), Front Range Community College (FRCC), Lamar Community College (LCC), Morgan Community College (MCC), Northeastern Junior College (NJC), Otero Junior College (OJC), Pikes Peak Community College (PPCC), Pueblo Community College (PCC), Red Rocks Community College (RRCC), and Trinidad State Junior College (TSJC). Two local district colleges, Aims Community College (Aims) and Colorado Mountain College (CMC), also participated. In respect to the grant's development and/or enhanced energy programming only seven of the COETC consortium colleges were involved. Table 1 identifies the seven energy colleges and the credentials—certificates and associate degrees—they offered under COETC. Only these seven colleges will also be the focus of this report.[2]

Table 1. INDUSTRIES SERVED AND CREDENTIALS OFFERED BY COETC COLLEGES

College	Industry	Credential
Aims	Oil and gas	AAS, certificates
CMC	Applied engineering, electrical instrumentation, energy efficiency, solar installation, oil and gas technology	AAS, certificates
FRCC	Electromechanical and energy technology	AAS, certificates
NJC	Wind energy	AAS, certificates
PCC	Mining and extractive technologies	Non-credit certificates
RRCC	Water quality management technology	AAS, certificates
TSJC	Line technician	AAS, certificates

[1] See APPENDIX A for a glossary of all abbreviations used in this report.

[2] For findings from the DE redesign see EERC's report: The Transformation of Colorado's Developmental Program: Observations and Findings; and The Transformation of Colorado's Developmental Program: Student Outcomes

An interim report on the seven energy colleges' TAACCCT-related work to develop and/or enhance their respective energy programs was released by the third-party evaluator, Rutgers' Education and Employment Research Center (EERC), in November 2014.[3] That report focused primarily on program implementation; the development of online and hybrid curricula and mobile learning labs; the role of the career coach and of industry advisory boards; and student outcomes as of spring 2014. This report builds off of the interim report.

EERC also released two final reports on COETC activities related to the revision of Colorado's developmental education programs for all 15 colleges within the consortium. These reports, "The Transformation of Colorado's Developmental Education Program: Observations and Findings" and "The Transformation of Colorado's Developmental Education Program: Student Outcomes," along with copies of all COETC-related reports published by EERC, can be downloaded on the EERC Web site at http://smlr.rutgers.edu/eerc/coetc.

The report that follows is an update on the fourth (no-cost-extension) year of the COETC's TAACCCT-grant-related activities and focuses only on the energy programs. It examines industry–college partnerships and employer perspectives on the seven energy programs; further changes in curriculum, career-coach activities, and best or promising practices for replication and scaling; and issues related to sustainability after the September 30, 2015, sunset of the grant. In addition, this report presents a final analysis of student outcomes in the state-redesigned energy programs, examining both the number of students served and the credentials earned as well as employment and wage data for those who completed programs at the energy colleges.

Methodology

As the third-party evaluator, we used a dynamic combination of qualitative and quantitative methods to track program development and implementation, identify achievements and challenges, and collect and analyze outcome data.

We conducted multiple phone and in-person interviews with project leads, energy faculty, instructional designers, data coordinators, senior college administrators, and, when possible, students. In addition, in spring 2015, members of our team conducted phone interviews with 10 industry representatives who were directly engaged in the TAACCCT project, whether as a member of a college's energy advisory board or instructional staff or as an employer of a graduate of an energy program such as the ones offered by RRCC, TSJC, NJC, CMC, and PCC. When possible, interviews were taped and transcribed.

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[3] McKay, H., Michael, S., Borie-Holtz, D., Lloyd, J., and Nazarova, D. (2014). *Colorado Online Energy Training Consortium: An interim report*. Piscataway, NJ: Rutgers University, School of Management and Labor Relations, Education and Employment Research Center. Retrieved January 21, 2016, from http://smlr.rutgers.edu/eerc/coetc

Throughout the grant period, members of our team acted as participant-observers on COETC-project conference calls and webinars and in face-to-face meetings with project leads and career coaches. We also developed and administered several surveys to project leads and career coaches, including a fourth-year project leads survey specifically focused on the industry–college partnerships that were developed during the grant period. Data collected in that survey will be analyzed in the initial, qualitative section of the report that follows.

In conjunction with the above activities, we used Nvivo software to analyze transcripts and other relevant documents—including quarterly reports and other documents and materials developed by the colleges—to identify themes and patterns.

The qualitative team worked closely with the quantitative team to triangulate the data analysis. The following report is therefore based on both quantitative and qualitative data collected over the course of the grant (fall 2011 through spring 2015), including both survey data and direct quotations from interviews with industry representatives/employers and project staff. The report also examines recent employment and wage data from the US Department of Labor Statistics.

PART ONE: COLLEGE–INDUSTRY PARTNERSHIPS AND THE TRANSFORMATION OF COLORADO'S ENERGY PROGRAMMING

Reflecting national and state attention to sectors as a model for workforce and economic development, the TAACCCT program was conceived and developed to foster partnerships between colleges and regional industries. By building on existent relationships as well as creating new ones, the partnerships established during the grant period were seen as a more formal means to exchange information and resources that would enable community colleges to better train workers to meet the changing needs of employers and to expand opportunities for individuals seeking to retool themselves for employment and advancement in the energy sector.

Over the course of the COETC grant period, each of the seven energy colleges expanded and enhanced its relationships with regional industries. This section provides an overview of the collaborative work that took place between the colleges and their industry partners. In later sections we will provide more details about some of the issues and topics touched on here, such as curriculum revisions, internships, employment readiness, career coaching, and the perspectives of industry partners and project leads. We will also identify the challenges that emerged and the benefits that accrued throughout the study period.

The Cultural Context

Colleges and industry live in vastly different worlds and cultures. These differences were often noted in EERC's conversations with industry representatives and with college faculty and staff. While academic respondents generally emphasized traditional students, classes, certificates, and programs, employers were more concerned about nontraditional students and specific skill sets needed by their industry. The sense of time was also very different in their respective worlds. Employers tended to speak with more urgency, as companies often need immediate action to keep production moving and meet consumer demands. In contrast, college-based respondents thought in terms of more gradual change because, given the restraints of the academic calendar and institutional requirements, it may take one or more semesters to develop a course or pathway that responds to new industry-specified content and have it approved by the necessary administrative bodies.

Despite these differences, however, colleges and industry share plenty of overlapping goals and common ground. Both parties are invested in the preparation of knowledgeable and skilled individuals who can meet the needs of a changing job market and economy and thus can enjoy economic stability and well-being. Both want to know how best to align the needs of industry with college structures and resources and how best to meet the challenges many students face with regard to accessing higher education and balancing studies with work and family demands. The TAACCCT grant provided a rich opportunity for colleges and industry to refocus their alignment efforts—to examine and revise curriculum content and format, upgrade training equipment, facilitate the development of internships and apprenticeships, and prepare students for success in the job market. It also enabled colleges to expand their student support services by, for example, offering career coaching.

Program Advisory Boards

In Colorado, local schools and institutions that offer career and technology education (CTE) programs and receive state and federal funds are required by the Career and Technical Act to establish program advisory committees or boards. These committees "assist educators in establishing, operating, and evaluating programs" and "provide expertise pertaining to technological change."[4, 5] They are required to meet twice annually but often meet more frequently.

Under TAACCCT, the colleges' energy program advisory boards were the principal mechanisms through which the colleges and industry worked together on developing or revising program curriculum and course content. In most cases, these advisory boards existed prior to TAACCT,[6] but now also attended to grant related activities.

The make-up of the advisory boards varied by industry and college, but membership generally included program faculty, industry representatives/employers, representatives of local workforce centers, and representatives of professional organizations. A number of the energy colleges had multiple advisory boards involved in TAACCCT work. For example, Aims Community College had two committees working on grant-related programs: an industrial technology committee and an oil and gas technology committee. Similarly, Pueblo Community College had several advisory boards, including one for welding technology and one for machining.[7]

The advisory boards at the seven energy colleges provided regular opportunities for the exchange of information about changing industry standards and practices, new industry technology and equipment, and the skill sets that industry needed—including soft skills such as professional ethics and leadership training. In fact, at PCC, one of the industry representatives not only identified the specific equipment on which students needed to train but also provided it to the college.

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[4] Colorado Community College System. (2008). *Guide to the operation of career and technical education advisory committees*. Denver: Colorado Community College System, Education Services, ii. Retrieved from http://www.coloradostateplan.com/CTE/AdvisoryCommitteeHandbook7-08.pdf
[5] Ibid, 1.
[6] The Colorado state government pursuant to the federal government requires that all CTE programs hold regularly scheduled advisory board meetings. See Colorado Community College System (2008). A guide to the operation of career and technical education advisory committees. Denver, Colorado: Author. p ii
[7] *CTE Advisory Board Minutes*. (n.d.) Retrieved January 21, 2016, from Pueblo Community College Web site: http://www.pueblocc.edu/CTE-Minutes/

We have certain pieces of electrical and hydraulic equipment that we use to mine coal. We were able to provide those pieces of equipment to the college—the electrical schematics, the hydraulic schematics—and they could use them in their MLL to develop scenarios for troubleshooting based on the equipment that we have.

Advisory boards were also a forum for discussions about internship and apprenticeship opportunities, the identification of anticipated job openings and employment trends, and advice on job seeking and application completion within specific industries.

In interviews and surveys, both project leads and industry representatives indicated that holding regular advisory board meetings was one of the most successful strategies for fostering and maintaining working partnerships between industry and colleges, and as noted above, during the TAACCCT project was one of the ways the colleges involved industry in the grant. The benefits of collaboration were seen as mutually reinforcing. From the college side, one of the project leads commented,

A sustainable program will do these things [hold regular advisory meetings] not because they are required but because we value our industry partners' opinions and advice. If we don't keep in contact with industry and stay current, we will not be able to produce a good product [employable students], the industry will lose trust in our program, stop hiring from us, placement rates drop, and administration will close the program.

From the perspective of industry, on the other hand, advisory boards were seen as an opportunity to share industry expertise, experience, and ideas, and to help shape the next generation of employees.

As one industry employer noted,

We have looked at different courses. What is good about it is that—if we see we are lacking something in the school, we can discuss it there. If we see that something important is needed, we tell them. They then adjust their curriculum, and that is helpful.

In fact, industry representatives repeatedly mentioned in their interviews how much they appreciated the opportunity to work with the colleges and how much they felt the colleges had *heard* what they had to say and were willing to redesign curriculum to better serve industry needs. In turn, the colleges spoke positively about industry's assistance with curriculum review and revision—"*[advisory board meetings were] the key strategy . . . to ensure students meet technical-level workforce requirements for future employment.*"

The Development of Online/Hybrid Curriculum

One of the goals of the COETC grant was to create "flexible" and "mobile" delivery options for certificate and/or associate-degree programs in the energy sector. Flexibility of delivery including online courses was seen as a step toward increasing program access for students living at a distance from a college campus as well as for students who were balancing work and family responsibilities with their studies. In addition, the colleges wanted to better serve the needs of workers already in the energy field who wanted to upgrade their skills or earn new credentials. These initial goals were achieved with varying results as discussed below.

Over the course of the grant the key strategy for achieving flexibility in course delivery was the transformation of coursework from traditional, face-to-face, classroom-based meetings to completely online or "hybrid" (a mix of online and in-person) classes. This was a huge undertaking, and the initial buy-in was mixed. Some were excited by the idea while others expressed outright resistance to creating and moving courses to online and hybrid formats. In the beginning some employers and instructors (both college-based instructors and those who were actively industry engaged) were concerned about how to determine what course or program content was best suited for an online format and what content needed to be conveyed through face-to-face interactions. Concerns about format were especially pronounced, if not resisted, for the line tech (TSJC) and wind tech programs (NJC). Representatives of those programs expressed the need for students' early exposure to climbing a pole or a tower and for hands-on experience. One industry-based instructor commented,

> *There are only so many things that you can do online. Obviously it is a very hands-on and physical job. I think it should be very specific things that you could teach online.*

At the same time, an RRCC industry rep acknowledged the potential offered by online courses to his incumbent employees:

> *What's happening is that our operators work 24/7. So once they are already in the field, they cannot go to college in person. A Web course is ideal. It took a while, but RRCC was proactive and developed an online instruction course that is live right now. And this directly came from industry needs.*

We quickly learned that many faculty members had no prior experience with online or hybrid formats. Anxiety about the unknown was itself a cause of some of the initial pushback. Instructors worried about what content would be malleable for conversion to online or hybrid formats. One industry-based instructor stated that the initial rollout felt like the *"blind (instructors) leading the blind (students and industry),"* but he eventually discovered multiple new resources on the web:

> *I learned a lot as far as the technology, in terms of addressing the students' needs. The online—I guess initially it was—I did not know what to expect since I haven't done anything like this before. Using discussion forums, using assignments, different ways to demonstrate to students how they can deal with tasks. Certain things I liked: for example, the testing portion, since I did not need to grade quizzes. There are pluses and minuses to this.*

For instructors, it was not just what content could be transformed into online content but also how to change the actual process of teaching and learning. They wondered whether online courses would provide the same level of interaction and understanding between the student and the instructor:

> *There is a bit of misinterpretation . . . online. When you read a question and you answer it, and you are looking at the instructor face-to-face and say that you don't understand a question, they can elaborate and explain. You cannot get that type of understanding online.*

Not surprisingly, as faculty discovered new tools, resources, and technology that they could use in class and remotely, and as they became more comfortable with online interaction as well as with the concept of the flipped classroom,[8] hybrid courses emerged for most instructors as the preferred format.

By the final grant-year interviews, the pushback and many of the concerns that we had previously heard had been replaced by general industry and faculty buy-in. Online and hybrid formats were eventually embraced, seen as beneficial both to the college and to students, as they enabled the college to serve larger numbers of students and incumbent workers interested in improving their skills and/or stacking their credentials. The advantages of the new formats are evident in the following comment by a college project lead:

> *RRCC collaborated with Colorado Rural Water Association (CRWA) to promote WQM courses that were designed to be offered in the hybrid/online format. CRWA staff actively reached out to the community and their members. This was a valuable contribution to this new format since rural professionals greatly benefit from educational opportunities that are offered online.* [9]

RRCC's water quality management faculty also *"embraced D2L (Desire2Learn) and the hybrid delivery of other courses."*

At Aims, there was actually a "*snowballing*" of support throughout CTE departments, with other faculty gradually "*join[ing] the 'online' bandwagon*."

Stackable Certificates

Prior to and over the course of the grant, industry partners were interested in academic opportunities for students, including incumbent workers, to stack their credentials – earning several certificates and/or a combining certificates and an associate degree. To facilitate stacking some of energy programs latticed coursework such that students could simultaneously or sequentially earn more than one credential. For example**, at** Aims, the courses for a one

[8] In a "flipped" classroom model, students read course lectures at home and engage in problem solving and "homework" exercises in class.
[9] Rutgers Education & Employment Research Center. [Response to project lead survey]. Unpublished raw data.

semester eleven-credit certificate "Introduction to Oil and Gas Technologies" are the same as those for the first semester course of an AAS degree in Oil and Gas Technologies. The one term certificate offers students the chance to "dip their toes in" the energy arena before committing to an associate degree. It also gives students the means to immediately enter the workforce. Students who earn this certificate can also elect to move into related certificate programs based on their career goals or changing interests.

The level of stacking and by whom, will be presented below in the outcomes section. [10] But it is important to note here that associate degree students were more likely to stack certificates than non-degree students. The factors contributing to this are not clear. Different rates of stacking may be by energy sector, number of interrelated certificates offered by the college, different degrees of knowledge about stackable options and opportunities, and/or different levels of contact with the COETC career coach, among others. It may also result from the way that programs were constructed. Given the industry's interest in stacking, this might be an important area for further study.

Teaching Soft Skills

Employers' concerns about workplace interactions stressed the need for the energy programs to add the development of "soft skills" to their curriculum—training in professional ethics and leadership along with skills such as the ability to adapt to changing conditions, to solve problems, think critically, resolve conflicts, communicate, and work well with others. Employers' concerns about soft skills are exemplified in this comment by an industry rep:

> *This field requires somebody who has a dynamic mind and who can multitask and can evaluate trends and operate in a proactive manner.*

The colleges in turn heard what industry reps were saying. The project lead at RRCC commented,

> *In the beginning RRCC was focused on technical issues of operation, and later it is more about supervision, management, and leadership-type services. So it is not only about operators anymore but also about the training of future leaders.*

The CMC project team observed the need for soft-skills training in their experiences with industry reps as well:

> *[We are] hearing from [industry] folks that you need to incorporate some more of that. You need to incorporate some more of that time management and communication and the whole teamwork piece into your classes, and I think that that's going to be an indirect benefit of this TAA is that we're going to have a stronger program.*

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[10] Also, see EERC's COETC Energy Interim Report for more discussion of stackable credentials.

Over the course of the grant, soft-skills content—including oral and written communication skills, professionalism (e.g., the importance of punctuality and attendance, keeping a positive attitude), multitasking, critical thinking and problem solving, and teamwork—was integrated into both existing courses and new courses, e.g. PCC, FRCC. Several of the TAACCCT career coaches were also assigned to lead workshops that addressed soft-skill development. For example, at RRCC the career coach used exercises from the *Bring Your A Game to Work* curriculum in her student workshops.[11] Her use of this program was then picked up by several other career coaches working at energy colleges.

Ongoing Program and Curriculum Revisions

While the majority of program and course revisions occurred in the early months of the grant period, colleges continued to review and modify curriculum on an ongoing basis as they received feedback from instructors (many of whom are actively engaged in industry), students, and members of their respective advisory boards.

The following are some highlights of the program and course changes that took place in the final year of the project. For more detailed project implementation information please see the interim report.[12]

Front Range Community College (FRCC)

During the grant period, FRCC changed its program focus and the name of its energy program from Clean Energy Technology to Manufacturing and Energy Technology (MET). The newly titled program offers a 4–5-semester, 64-credit AAS degree as well as a two-semester, 32-credit certificate.[13]

In March 2015, MET moved into a newly constructed building, Little Bear Park, on the Larimer campus—expanding its classroom space and gaining additional and enhanced lab facilities for students.[14]

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[11] Chester, E. (2011). *Bring your A game to work.* Denver, CO: Center for Work Ethic Development. Available from Center for Work Ethic Development Web site: http://www.workethic.org/solutions/bring-your-a-game-to-work/

[12] McKay et al (2014), op. cit.

[13] For details on these programs, see the following Web page: Front Range Community College. (n.d.). *Academic Programs: Manufacturing & Energy Technology*. Retrieved January 21, 2016, from www.frontrange.edu/programs-and-courses/academic-programs/electromechanical-energy-technology

[14] Feeley, J. (2015, March 9). What's inside the newest Larimer Campus building? *Writing the Front Range*. Retrieved January 21, 2016, from Front Range Community College Web site: http://blog.frontrange.edu/2015/03/09/whats-inside-the-newest-larimer-campus-building/

In the final grant year, FRCC used project funds to facilitate two major endeavors to expand training resources and student opportunities. The first was FRCC's agreement with Colorado State University's Engines and Energy Conversion Lab to use its steam power plant (named "the Powerhouse"). This agreement affords MET students the opportunity to receive on-site, technology-based training and certification in power generation, power plant management, and smart grid industries. At the time of this writing, FRCC was engaged in extensive safety testing and in the creation of comprehensive troubleshooting documentation so that students would be able to make use of the plant by fall 2015. In addition to the steam plant, FRCC's MET program gained access to a "one-of-its-kind" solar lab on the Larimer campus. In sum, FRCC used a total of $380,000 from the TAACCCT grant to purchase equipment for the power plant and the solar array laboratories.[15]

To align and coordinate course content with the new training facilities, FRCC faculty have been busy revising its curriculum (e.g., PPT 116 and ELT 238). Further, in response to a request from the utility industry, FRCC created a new course in 2015, ENY 161, for conventional and renewable energy students. This course, which replaces ENY 160, covers: "different ways to generate energy, regulatory impact, safety procedures and equipment, and energy transmission systems."[16] FRCC also developed MTE 135, a lean six sigma course,[17] which will be launched during the 2015–16 academic year.

Aims Community College

A growing pool of Aims' energy faculty are transforming courses and/or modules into online/hybrid formats as they recognize the flexibility that such courses offer to both instructors and students. Aims, which has a strong online learning department, has hired one additional instructional designer to work with the energy faculty on its format assessment and redesign process.

Colorado Mountain College (CMC)

CMC faculty are adding more online and hybrid options to the college's certificate and degree programs in process technology. These reformatted options launched in fall 2015. In addition, CMC faculty are engaged in continuous refinement of their courses—adjusting lessons, adding and removing content, and/or identifying new resources that can facilitate student learning. Revisions are also being made in the assessment tools faculty use in their courses.

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[15] Feeley, J. (2015, June 15). Get hands-on training in manufacturing & energy technology. *Writing the Front Range*. Retrieved January 21, 2016, from Front Range Community College Web site: http://blog.frontrange.edu/2015/06/15/get-hands-on-training-in-manufacturing-energy-technology/

[16] Front Range Community College. (2015). *ENY 161 Energy industry fundamentals.* Retrieved February 8, 2016 from http://frontrange.smartcatalogiq.com/en/2015-2016/Catalog/Courses/ENY-Energy/100/ENY-161

[17] Lean Sigma refers to a management training relating to quality control strategies and waste reduction in manufacturing

Northeastern Junior College (NJC)

The wind tech program at NJC has initiated an applied learning project in which second-year students design, build, and program an electrical trainer that will be used for further student training.

The wind tech program has also been one of four iPad pilot programs at NJC. These iPads provide students and faculty increased flexibility in the classroom and labs—reducing the need to be sitting in front of a PC or laptop. Faculty and students have found that iPads increase the ease of transferring data to one another. An unforeseen benefit of the iPads has been the almost total elimination of printing costs related to faculty members copying and distributing classroom materials.

Faculty observe that the iPads have increased students' ability to look up data instantly, making the device, according to one respondent, "*a game changer in the classroom*." Another noted, "*We can focus on critical thinking instead of memorization, which is what is needed in the industry*." NJC faculty also observed that the interactive iPad applications have increased student engagement. For example, an app called EveryCircuit now enables students to build circuits directly on their iPad and then power them up. The app has the capacity to indicate current flow and voltage drop and to graph the information in real-time. The project lead/ principal instructor stated,

> *This app will forever change my basic electrical class and will take us farther than I could have imagined in a single class. We are still trying different things and will likely have to keep adapting as the technology changes, but this tool gives us some significant advantages over a traditional setting.*

He further commented,

> *Information literacy is a key to any technical position. Instead of the student being limited to the one textbook that I choose for the class, we can use the hundreds or thousands of technical manuals for any piece of equipment or part available from the Web. A student needs to be able to find relevant information quickly to accomplish a task that may be critical to the operation of the system. . . . [S]tudents use their fundamental knowledge that they learned early in their schooling to understand complex problems that may not have a single solution, which is exactly what you will see in the field.*

Pueblo Community College (PCC)

PCC continues to offer unique on-site non-credit incumbent worker training programs to regional employers. Trainings are tailored to the specific needs of the employer. As a result, standards and practices are continually updated across training modules and programs.

Given the highly specified nature of most of the training, however, there has been little use of online or hybrid formats. However, PCC did make extensive use of the MLLs in these off-site trainings.

Trinidad State Junior College (TSJC)

TSJC has long-range plans to ensure that all online courses meet Quality Matters standards,[18] which require that all course materials are regularly updated and that they meet Web accessibility standards. To this end, TSJC recently wrote a part-time program evaluator into the college's Carl D. Perkins grant. If approved, this position will enable the evaluation of all CTE programs in respect to their rigor and relevance to industry standards.

Curriculum Improvement Using External Consultants

The TAACCT grant provided multiple opportunities and needed resources to review and revise course content and pedagogy – increasing intentionality of respective program curriculum – connecting it to what students would do when employed. In addition to the ongoing collaboration of faculty and advisory boards to review, update, and revise program curricula, several energy colleges also engaged external consultants to ensure that their certificate and associate degree programs meet the changing technology and field processes of the industries they are designed to serve.

Red Rocks Community College (RRCC)

This past year, as part of its effort to *"determine strengths, weaknesses, and best strategies to improve the Water Quality Management program,"* RRCC hired a market research firm. The firm conducted focus groups with five industry professionals during which they asked questions related to course content, as well as *"teaching, internships, field trips and guest speakers."* The results from the focus group were transformed into a survey that was distributed to a sample of the 5000 industry professionals in the Denver metropolitan area who have wastewater management certificates from the industry's state certifying organization, the Operator Certificate Program Office. The result of the survey will be used by RRCC to review and revise its water quality management program.

Colorado Mountain College (CMC)

CMC also contracted with a consultant to help them review and redesign their energy courses. A major focus of these revisions will be on enhancing course-specific learning objects and embedding them in hybrid and mobile-lab courses.

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[18] Quality Matters certifies the quality of online course materials using a peer-review process. (Quality Matters. [2016]. *Higher Education Program*. Annapolis, MD: MarylandOnline. Retrieved January 23, 2016, from https://www.qualitymatters.org/higher-education-program)

Developments in Teaching

The employment of industry personnel as course instructors has benefited both industry and the colleges. At TSJC's Trinidad and Colorado Springs programs, line technician instructors are seasoned, experienced line technicians. At RRCC, many of the water quality management technology instructors are full-time water utility employees.

RRCC's project lead identified hiring instructors with industry experience as the best practice for the college's WQM program. At the same time there are challenges in respect to finding industry people who want to work full time at the college, and/or who's teaching skills equals their industry knowledge and skills. This opinion was shared by NJC's project lead:

> *Your instructors must come from the field to have a successful energy program. A science or tech instructor can do the job, but they lack the safety and industry experience to engage the students at the technical level. Your instructors must be full time, since adjunct instructors are not available to support the students outside the classroom. To be honest, it is hard to find an industry guy/gal that can teach well. It will take them a couple of years to develop the teaching skills.*

Students shared with us how much they appreciated having course instructors who spent part of each week in the field. Such instructors brought coursework to life by providing rich examples of practice issued from their own experiences, thereby exposing students to the realities of day-to-day field activities and the skills—including problem solving and crisis management—that are critical for success. The industry-based instructors were also able to coach students in their job searches and prepare them for interviews.

For industry, instructors provided a bridge from the college into the company. Instructors were able to observe the students and identify the stars, many of whom they would go on to recruit for their company. As one industry-based instructor commented,

> *There is a benefit from my standpoint as I get to see future generation and . . . recognize who the future stars are, and I can also try and change concepts and philosophies in industry.*

As we will discuss later, this was also one of the advantages that employers valued about the use of internships.

Project leadership, however, did share with us some concerns about using part-time instructors. Given their other work responsibilities, some part-time faculty were unable to fully engage in curriculum redesign or to meet redesign deadlines. And given work schedules, some industry-based instructors were not always available for student advisement. In this context, it was interesting to note that project leads commented that college-based faculty needed more opportunities to engage in industry-specific or technology-specific training as their fields changed. According to the FRCC project lead, *Ensuring that faculty maintain currency in the fields—it offers credibility to our program and builds our partners' confidence in the certificates and degrees we're issuing.*

Finally, while most of the initial attention to online and hybrid courses was focused on how they responded to the needs of students, attention gradually increased with regard to how these formats could also respond to the needs of industry (for example, by facilitating an expansion of the colleges' incumbent worker trainings). In fact, at PCC, much of the training done under the grant involved safety training for mining employees in southwest Colorado and preparing workers for exams related to industry credentials, including those for commercial driving licenses and OSHA's mine safety certification. Parts of these program were made into online formats but some components could not be done online.

Mobile Learning Labs

The construction and deployment of mobile learning labs (MLLs)—vans or semitrailers containing lab equipment—was yet another strategy for conducting off-site, technology-enhanced, hands-on training.[19] MLLs have been used by faculty to conduct classes both on and off campus and have been especially helpful in reaching remote areas to meet the needs of field-based incumbent workers. The MLLs constructed with grant funds by CMC, RRCC, and PCC have been positively received by faculty and employers. However, as indicated below, there are some real challenges with regard to the sustainability of their use. Please see the interim report for a more in-depth discussion of MLLs in the grant.

Pueblo Community College (PCC)

Prior to the TAACCT grant PCC designed and developed two MLLs which were extensively used for tailored, on-site, incumbent worker trainings. As such they were Colorado's pioneers in the use of MLLS for teaching and training. Under the TAACCCT grant PCC developed two additional MLLs which were widely used. PCC relies on a fee-for-services model in its training contracts with business and industry to defray the costs of MLL maintenance and logistics/travel costs. This model enables the sustained use of the labs and might become a model for other colleges.

Red Rocks Community College (RRCC)

Under the grant, RRCC built a MLL which they have used less in the field and far more as an on campus instructional lab for the WQM 121 class, e.g. environmental sampling. In addition, and as noted in the interim energy report,[20] RRCC's WQM MLL is registered as a

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[19] See EERC's report: COETC Energy Interim Report for further details on the development and use of the MLLs.

[20] McKay et al (2014), op. cit.

Colorado Water/Wastewater Agency Response Network (CoWARN) Emergency Response Laboratory. As such, it is equipped to assist the Colorado Department of Public Health and Environment in testing water quality in a public health emergency.

RRCC, however, remains concerned about the logistics of operating its MLL, which involve staffing, maintaining insurance, and operation and maintenance expenses and logistics. This year the college convened a strategic planning group that includes members of the Student Success Services, Business Services, and Instructional Services offices to explore potential funding resources for the continued operation of the MLL. HB15-1271, a bill enacted in 2015 by the Colorado legislature that "allows moneys in the Colorado existing industry training program to be used to fund mobile learning labs," may present new funding opportunities.[21]

Colorado Mountain College (CMC)

CMC has established a partnership with Climax Mines in Leadville and has, over the past year, provided a number of on-site incumbent worker trainings using its MLL. The operational costs for CMC's MLL come from student tuition fees and/or, like PCC, from the fees companies pay for MLL trainings.

Internships

Over the course of the grant, a total of 51 students (FRCC, RRCC, CMC and NJC) participated in an internship with employers in their service area. While only a small number of students had this experience some important lessons were learned from these partnerships. Internships emerged out of active college–industry relationships and provided additional glue to strengthen those relationships. This mutuality of accrued benefits was referenced by all of the employers with whom EERC spoke to who offered internships. Internships enable students to apply skills and engage in the actual processes that have been discussed in the classroom. Internships help students *"explore a specific career area or industry"* and *"provide students with opportunities to apply their growing knowledge and skills" "Everything they learned in class comes together. So it helps to reinforce that part"* and to help students become connected to potential employers.

One employer noted that some internships enable employers to observe how students work with one another and find out whether they *"fit in the organization. Are they are asking relevant questions? [When we take on an intern, we] are looking at compatibility as well."* Or as another employer stated,

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[21] Colorado House Bill 15-1271, *Concerning the funding of mobile learning labs through the Colorado existing industry training program.* Retrieved February 8, 2016, from the Colorado General Assembly Web site: http://www.leg.state.co.us/clics/clics2015a/csl.nsf/fsbillcont/8F4C2641FE6AE8BB87257DFD007A39D3?Open&file=1271_enr.pdf

I take a lot of internships because I get to see students and how they perform before they get to the hiring process. Last operator I hired here, his internship greatly influenced a recommendation for employment here. So I get to try before I buy.

For some students, internships serve literally as pilot employment. An employer working with PCC explained,

[Our interns] have to be enrolled full time in community college or four-year school. Their interest needs to be in one of the areas—mine engineering, environmental engineering, chemistry, biology, survey, auto parts, and heavy equipment. When they start, they are paid 16 dollars an hour, but they don't receive benefits. They are treated as full-time employees and thus [are] expected to follow all company's policies. But this gives them an opportunity to work in the career field they study for. This internship allows them to do the work while they are completing their education. We recruited graduates who had internships with us several years in a row.

Employers also spoke to us about how students have helped inform their mentors and thus have positively impacted the incumbent workforce. One employer noted,

I assign interns to supervisor-operators. I have heard on occasion that operators have picked up something from the students. This is because of the textbook, or something came up in the class in a different facility.

The benefits of internships were summarized by the FRCC project lead:

[It] benefits students by giving them a real experience in the field. It benefits the college because internships pick up experiential learning components that the college can't offer because of limited resources. And it benefits the company because they can use it as a hiring tool—what better way to determine if the student is a good fit for the job than to see them in action on the job?

While the majority of employers and industry reps we interviewed perceived internships as a positive experience, there have been challenges. The employers in some fields were unable or unwilling to invest resources in the future workforce. When asked about this issue, one of RRCC employers noted,

My gut tells me it is money. Also, probably people in the industry just think 'we just hire somebody else.' But what they don't understand is how much training it takes to grow a specialist to operate one of these facilities.

Overall, however, we found that the most common reason for employer hesitation about offering an internship was company liability for injury or loss of equipment. RRCC was able to resolve this problem by having the college carry the liability for their students. This enabled some employers to offer internships that wouldn't have been able to otherwise, as one RRCC partner explained:

> *[Liability] is a brick wall in internship programs. When we hire interns, we only hire people who are coming via college because they are covered by the college. We do not hire interns off the streets and if they are not coming from RRCC. It is an unpaid internship. So they come through the college, and it is part of their college curriculum. Liability covered by college is the only way we could have interns.*

In the case of the wind program at NJC, the liability issue could not be resolved, and the college dropped a previously required summer-internship practicum. Going forward, best practices with regard to liability insurance should be shared, and new policies and resources need to be explored by the colleges, their industry partners, and perhaps even relevant professional associations in order to facilitate additional internship opportunities for students.

Changing Perceptions on Next-Generation Recruitment and Employment

Interestingly, our interviews with employers revealed evidence of changes in their perceptions about hiring younger people who, as some experts say, are more digitally-enabled, diverse, idealistic, social, collaborative, and ambitious.[22] This is consistent with the literature on next-generation recruitment, which argues that hiring tomorrow's workforce demands fundamental shifts in recruitment approaches: focusing on capabilities rather than skills, and allowing people to have more flexibility and a greater sense of control over their lives and jobs. [23]

Employers in Colorado have therefore been paying more attention to the potential capabilities of the candidates rather than on their formal skills and demonstrated knowledge. Thus, according to an RRCC employer who is also a college instructor,

> *As an instructor I can see who 'next-generation' is. It is not about knowledge but about aptitude, and I am going to go after those having a right aptitude. Having a lot of degrees and certificates is not always a plus, but it is not a minus either. It is all about aptitude and whether they can and are willing to learn.*

In the same fashion, a CMC industry partner describes that company's recruitment practices:

> *I think when we interview people, we are looking for personal ethics, ability to push themselves outside the comfort zone, and the willingness to learn and be taught. We have done a really good*

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[22] Scott, R. (2012). Modern day recruitment: You need to think differently. *Presence of IT.* [PowerPoint Presentation]. Retrieved January 21, 2016, from LinkedIn Corporation, SlideShare Web site: http://www.slideshare.net/robscottinsyd/next-generation-recruitment

[23] Call, W. M. (2013, November 5). Recruiting and employing the next generation. [PowerPoint Presentation]. Retrieved January 21, 2016, from Networks Northwest Web site: http://www.networksnorthwest.org/userfiles/filemanager/2241/

job. We took auto mechanics, tool pushers, real estate flipping houses, and we trained them to be technicians and to be board operators. We mentored them, we pushed them, and we have got a very efficient crew now. I think, the ability to learn and progress, they themselves realize that it makes them more marketable.

For some employers, however, selection based on work ethic rather than on professional skills is a matter of necessity rather than choice. PCC employers, for example, reported that the remote geographic location of their mines makes it difficult to find skilled workers willing to relocate. The only workforce available are local people with *"great work ethics"* but with a *"background in farming or [who are recently] coming out of high school."* As a result, as discussed below, the mines decided to grow professionally skilled workers in-house by utilizing TAACCCT-grant and community-college services to train locally recruited employees.
At PCC,

Staff has partnered with industry to develop internship opportunities for students. In addition, fourteen industry partners served as panelists at the Career Exploration Day in April 2015. We found it was a highly effective strategy to recruit new students and connect current students with potential employers.

At Aims, the partnership with industry led to its programs' enhanced legitimacy, which increased industry's willingness to hire its graduates:

We built that [program] with industry input. And so they are recognizing it. Most [of] our partners have said 'if we see that [the energy certificate or degree] on somebody's resume, we'll give them an interview.' So it's really built around what they [the industry experts] want us to do.

Improving Employability through Apprenticeships

In addition to the more traditional recruitment strategies—internal and external job postings, online aptitude tests, observations, and interviews—energy companies are also turning to apprenticeship programs on a very small scale. Again while the experience with apprenticeships was small in scale during the grant some lessons can be learned from the experience.

The US Department of Labor defines apprenticeships as "a combination of on-the-job training and related instruction in which workers learn the practical and theoretical aspects of a highly skilled occupation."[24] Apprenticeships offer a specifically designed job opportunity for entry-level and journey-level workers.

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[24] United States Department of Labor. (n.d.). *Apprenticeship*. Retrieved on January 21, 2016, from http://www.dol.gov/dol/topic/training/apprenticeship.htm

In Colorado, the energy sector uses a number of different apprenticeship models. For example, training and employment for line technicians is a four-year, supervised training period that is divided into three separate stages, each of which is followed by a performance evaluation and by national standards tests. These tests culminate at the level of journeyman. Students who have graduated from TSJC must still move through the levels, but they may do so at a faster rate than someone who lacks a TSJC certificate or associate degree.

In contrast, CMC and one of its employers established a two-year electrical-instrumentation apprenticeship that involves a streamlined process of formal training on technical skills developed specifically for incumbent workers. Upon the completion of this training, the employees can choose to earn their CMC associate degree by taking additional credits in arts, humanities, and other core subjects that they may need in order to complete the degree requirements. This CMC apprenticeship uses the college's grant-funded MLL along with video-conferencing to eliminate the need for students to travel between their work sites and the college while still allowing them to interact with instructors and with one another. The student-employees are paid their hourly wage, benefits, and college fees. This apprenticeship, supervised by employer-mentors, combines morning sessions featuring hands-on training and video lectures with afternoon sessions centered on the use of simulators in the MLLs. Although not a state registered apprenticeship, the employer has been very satisfied with this model of apprenticeship and anticipates it will be replicated by other employers:

> *I am pretty pleased with what we have put so far, and I would be very reluctant to change things. What is also good is that by the end of our first three-year program, this will be a sustainable program for CMC—whether we [are still] sending students there or not—as other companies will be doing it.*

Employers sponsoring apprenticeship programs, however, registered some concern about post-training attrition. Some of these newly trained employees stayed within the companies that trained them but changed job positions and/or geographic location, while others sought jobs at other companies for higher pay.

> *I have spent a lot of time and efforts on this program to get people certified, and now that they have their certifications they take advantage of it and look for other places to continue their career and leave to work somewhere else. . . . So they quit, chasing some better opportunities, and then eventually they come back. That frustrates me when I try so hard for our workforce to be where they need to be, and then they just leave. Usually it is the young workforce [who does this].*

It is not clear what the actual rate of attrition has been by apprenticeship program or field. Although the possibility of having apprentices sign commitment contracts was discussed within some companies, not one of the employers we interviewed requested that apprentices sign such a contract during the study period. When asked, employers spoke about why they had not pursued such contracts. In the case of a former apprentice staying within the company, an employer observed, *Even if you lose them as a lineman, you still retain them as an employee who has value to the company.*

An employer who is working with CMC dismissed the idea of such contracts even when there is the possibility of an employee leaving the company:

We talked about [requiring commitment contracts] and decided that we are putting substantial investment in each of these apprentices, and we wanted to set up a forgivable loan so they have an incentive to work for the company an additional three years. Our parent company, however, said that this is not how we work. We invest, but if a person wants to leave for a better opportunity, they can do it. But our preference is that we are an employer of choice, and they want to stay.

The practicality of using contracts as leverage to maintain trained employees subsequent to an apprenticeship was also negated by an employer working with PCC:

I have considered doing some contracts saying that you have to work at least one year after the training or pay back the money that we have spent on you, but that is silly and not fair. Many people would never sign this kind of contract.

Finally, one of RRCC's employers summed up apprenticeships as an investment in the improvement of the field or trade, noting that alone could be the "payback":

There is always this question—What if they leave? Well . . . at least we are putting out there more educated operators.

Incumbent Worker Training: "*From hiring the best to educating the best*"

In addition to the recruitment of new employees and a small number of apprenticeship programs, the employers we spoke with also discussed the need to further train their incumbent workers. For many, the challenge was how to engage in incumbent worker training given the associated costs of release time and/or tuition fees.

The following quote showcases the struggle of one employer working with PCC:

They [in the company's corporate office] are of the opinion that we should hire qualified staff in the first place, but what they don't realize [is] how difficult it is to make these qualified people relocate to this small area. So without the grant money initially, I would never have been able to approach the management and owners and say, 'This is what we need.' When I am presenting them that we need to train 10 people and it will cost forty thousand dollars, they are not so supportive, as they are not going to spend that amount of money on ten employees. And we have 170 employees. So I was able to take those [grant-related] proposals to our general manager and say 'Listen, this is how much it would have cost, and with this grant, this is how much it will *cost. When we complete the training, these employees will be certified in different areas.' Once they look at the training in that sense—with grant money—they say, 'Go for it, that's fifty percent savings.'*

The success of this incumbent worker training reflects the work that PCC has done, first under the Colorado State Department of Labor and Employment Sectors' project and more recently under the TAACCCT grant. Under both projects PCC has reached out to the oil and gas companies in southwestern Colorado and has provided noncredit training courses often tailored to a specific skill set. Some of these courses have utilized PCC's four MLLs.

In addition, PCC is working with another company that had struggled to locate individuals with technical expertise in electrical mechanics. In this case, PCC identified faculty to provide specialized electrical training and training in hydraulics. The courses will make use of the college's MLLs so that trainings can be scheduled around employees' schedules. Such collaborations facilitate the training of workers in remote areas, enabling incumbent workers to earn additional certificates while employed.

CMC also partnered with regional companies to establish training opportunities for incumbent workers. One industry partner described a positive experience:

I solicited CMC to give some training to our staff. We organized ten days of training for our tech staff covering soft skills, safety and environment, conflict resolution, report writing, and conducting of meetings. This was very high-level training. I was impressed. I think this is to do with CMC attracting professionals to teach. It was twenty staff members [who received training]—from management to new technicians. CMC did a great job working with all of them.

A number of the employers we interviewed contrasted working with a public community college with contracting with private educational institutions:

It is nice to have a college here because they are willing to build their curriculum based on our needs. Without the college here we'd have to bring in tutors to teach people electricity and stuff like that. That is very expensive. The quality of the teaching by independent contractors is not better than the college provides. It made the opportunity to increase education affordable and available to us that live in the Four Corner area.

Career Coaches

The career coach position was established under TAACCCT to facilitate the progress of students enrolled in energy programs as well as to serve the needs of students in developmental education (DE) courses across the consortium.

Coaching functions at the energy colleges included academic advising (e.g., developing students' success skills), career planning and job/interview preparation, counseling and referrals for a wide range of social and financial support services, student recruitment, and working with industry partners. The specific blend of coaching activities utilized by each program reflected: a) the nature of existing student support services at the college, b) the location of the coaches' offices in relation to the energy program, c) the career coaches' prior experiences, and d) the needs of different cohorts of students—e.g., residential, part-time, incumbent workers, and/or students who needed to complete DE requirements.

A detailed report on the role of the career coach was issued by EERC in January 2014.[25] The current report provides an update on coaching activities at the energy colleges and discusses the future of the career coach position and its function after September 30, 2015—the date the grant period ended. Data discussed in this section come from recent quarterly reports as well as from the spring 2015 project lead survey referenced above.

In addition to their work with energy students, coaches at a number of the energy colleges also worked closely with DE students. These coaches assisted students with application and registration procedures as well as helped students explore possible career paths. For example, the coach at NJC used Knowdell Card Sorts[26] with students who had not yet decided on a career or occupation. That coach found the sorts to be "*extremely helpful for students who really don't know what they want to do.*" At some energy colleges, career coaches also answered questions about their institutions' energy programs, thus helping recruit talent for these programs.

For both DE and energy students, TAACCT funded career coaches monitored students' academic progress—either directly as part of their college's early-alert system or through faculty's identification of students experiencing difficulties. As one project lead observed, an important part of the role of the career coach was to act as an "*extra pair of eyes and ears that can help direct the student back down the right path or find them a new one if they just don't like the work.*"

Further, coaches were instrumental in assisting students who were returning to college to "*negotiate the system*"—helping them find whatever academic or financial supports they needed.

Study skills, as well as what are called "soft skills" in the employment sphere, were other foci for coaches' work with students. Coaches led in-classroom sessions, ran independent workshops, and worked one-on-one with students on these skills.

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[25] Michael, S. (2014, February). *TAACCCT Career Coaches: Findings and Observations*. Piscataway, NJ: Rutgers University, School of Management and Labor Relations, Education and Employment Research Center. Retrieved January 21, 2016, from http://smlr.rutgers.edu/eerc/coetc

[26] Knowdell describes his Occupational Interests Card Sort as "a low-cost technique for quickly identifying and ranking occupational interests [that] clarifies the high-appeal jobs and fields; the degree of readiness, skills and knowledge needed; and the competency-building steps for entry or progress within an occupation." (Knowdell, R. *Knowdell career assessment instruments*. [2016]. San Jose, CA: Career Network Inc. Retrieved on January 27, 2016, from the Career Development & Adult Development Network Web site: http://www.careertrainer.com/trainingsys/career-values-card-sort-knowdell-cards-ff80808117d194ac0117eb2af71f044d-p.html)

Case management—helping students to overcome any personal, economic, and/or financial barriers to success—was another major focus for the coaches. One coach commented,

> *I know that case management has come under criticism because it's expensive to administer. However, for many of our students, coming back to school is such an area of uncertainty; having one person who knows the answer (or who can help find the answer) helps students build their confidence and take ownership of their educational experience.*

A number of coaches (e.g., those at RRCC, PCC, and CMC) established and continue to maintain good working relationships with industry partners, recruiting incumbent students, developing and coordinating internships (RRCC), and identifying current and anticipated job openings. In addition, some coaches worked with the HR departments of regional employers to better understand industry needs and facilitate the matching of students with job openings. Coaches at many energy colleges (e.g., FRCC, PCC, and Aims) also worked closely with regional workforce centers.

One of the coaches' most critical activities was preparing students for entrance into the job market. They explored job opportunities with students, helped them with cover letters and resumes, and helped them, *"navigate many different types of online applications."* These are all skill-based, capacity-building activities. As one coach recalled, this sometimes meant *"spending many hours and several days with each student individually to make sure they get it right and know how to reproduce it when they get into the field."*

Coaches also conducted mock interviews with students,

> *. . . to get the student past the jittery rambling stage, to become really prepared for an industry interview. The student has to have confidence and believe in themselves when they sit down in front of a panel of managers and technicians who are trying to get you to red flag yourself.*

During the final grant year, coaches added two critical functions to their role. In reviewing the transcripts of energy students, they noted that some students had left their programs missing only a few credits, and others had left having fulfilled all requirements but without ever formally applying for their earned credential. In response, one coach began reaching out to these students and facilitating either the completion of the credential and/or the application for the already earned credential. The success of these activities, which coaches conducted in conjunction with their colleges' Registrar's and Records' Offices, led directly to an increase in the number of students who completed one or more credentials in each school's energy program(s). For example, as a result of these efforts, an additional 76 students were eligible to be issued a total of 160 additional credentials at RRCC they had not previously held. In response to the success of these activities, RRCC changed its policy with regard to the awarding of credentials. RRCC is creating an automatic certification system so that students no longer have to apply for any credential; instead, the college will automatically award credentials to students as soon as they have fulfilled all requirements.

Sustaining Career Coach Functions

Faculty and college administrators recognized the many contributions that the career coaches made to strengthening student retention and completion rates over the course of the four-year COETC grant. However, given existent resources, most of the energy colleges found they would be unable to sustain a dedicated career coach position after the sunset of the grant. Instead, throughout 2015, the majority of energy colleges (FRCC, RRCC, CMC, Aims, and TSJC) shifted some of the duties of their career coaches to faculty, academic advisers, and/or student services staff. It is unclear, however, post grant to what extent these career coach functions or specific services that were instituted under the grant have been integrated into other job titles, and/or if some activities are no longer being provided. For example, at CMC, a new faculty hire has absorbed many of the functions of the career coach in addition to his teaching responsibilities. At Aims, "ramped up" student services and retention advisors have taken over their COETC career coach's functions. These staff members are supported by institutional funding.[27]

Two exceptions to the above shifts are PCC and NJC. In both cases the colleges were able to identify alternative resources to support the continued work of their career coaches. At PCC auxiliary funds will be used to continue its career coach's outreach to, and work with, industry partners. That coach will also work to maintain the college's strong partnership with Colorado's southwest regional workforce centers and will be available to meet with students on an "as needed" basis.

In anticipation of the end of the grant, NJC moved funding for the career coach position into its general fund. However, because that funding stream also includes nonenergy programs, the career coach's responsibilities will grow. In addition to assisting wind program students, she is also responsible for all CTE, DE, and at-risk students. The focus of her work, however, remains on helping students define their career goals and/or helping them change career paths when they find it is not working for them.

Promising Practices

In reflecting on the past four years of the TAA/COETC-funded project, a number of promising practices have emerged. These practices, which reach across activity categories, can help sustain industry–college partnerships and collaborations, help better train the next generation of employees, and facilitate continued capacity-building for energy programs as well as incumbent workers. Some of these practices have been identified in the above discussions,

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[27] It should be noted, however, that a number of the energy colleges (Aims, CCD, FRCC, LCC, PCC, PPCC, and RRCC) are involved in the Phase IV US Department of Labor TAA-funded Colorado Helps Advance Manufacturing Program (CHAMP), which employs "career navigators" who function in many ways like the COETC career coaches.

where we also identified some of the challenges of their use and/or institutionalization. In the hope sustained attention to one or more will be stimulated, we have we have assembled them here for ease of reference.

Productive use of Advisory Boards

As indicated above, advisory boards are required for all CTE programs in Colorado under the Career and Technical Act[28] and were not new to TAACCCT grant. Nevertheless, under the grant many college advisory boards were "ramped up" grant activities and staff brought new activities, focus and attention to many of the boards. The following are some of the observations that emerged from college and industry members of boards as a result of their grant focused activities.

- It is important to invite the 'right' people from industry to join advisory boards. For example, in addition to employers, it is useful to invite those who award industry certifications and conduct relevant testing (one RRCC board member was the president of a state certification program). Moreover, engaging non-board members in the process of, say, curriculum development—as was done at CMC—brings a wealth of knowledge and ideas to the table.
- Advisory board meetings should be focused and relevant to the industry partners in attendance. One college-based respondent noted that, "*[Through advisory boards we] keep in contact with the industry partners, but you cannot smother them. They are busy and often don't have time for idle chit-chat during working hours or [for] items that are not directly useful to them. Use the advisory committee meetings to explore changing trends that they are dealing with today so that you are preparing the students properly.*"
- Strategies to establish and strengthen relationships with employers might include on-site meetings, use of e-mails and newsletters to update them on campus and program activities, Web site postings, and phone conversations.
- Colleges should view the industry advisory board as an opportunity to foster an enhanced sense of investment and community among its members.
- Advisory boards are also a good platform for discussing the possibility of industry bodies—employers, professional organizations, etc.—donating equipment to colleges for training purposes. A number of in-kind donations helped equip the MLLS and college labs, e.g. CMC.

[28] The Career and Technical Act (CTA) prescribes minimum standards for program eligibility for reimbursement from funds provided by the Career and Technical Act and the federal Carl D. Perkins Career and Technical Education Act of 2006. The Colorado legislation includes the requirement that each Career and Technical Education (CTE) course shall ..."have a Technical Advisory Committee (23-8-103, C.R.S.)."

Industry Employees as Instructors

The employment of current industry employees as part-time instructors can foster a strong link between the classroom and the field. Industry-based instructors provide real-time information about changes in the field, enrich class discussions with actual field experiences, and enable employers to identify star students whom they can hire upon graduation. However, as mentioned above there are also some real challenges with this practice.

Development of Online/Hybrid Courses

- Specific discussion of online/hybrid curriculum with industry employers reduces resistance to online instruction and helps foster agreements about which content is best communicated through hands-on experiences and which lends itself best to online learning. This in turn fosters greater buy-in and ultimately greater legitimacy for the program

Job Readiness and Soft-Skills Training

- Embedding training in soft skills and job preparedness, including resume writing, into program courses—as was done at TSJC—increases students' readiness to enter the job market.
- Internships can be a valuable experience for both students and employers. Students gain field experience, and employers gain access to the potential workforce while also learning from them.

Use of Mobile Learning Labs

- On campus, MLLs can provide students with opportunities to gain hands-on experience in a controlled environment.
- Off campus, MLLs can facilitate the training—and credentialing—of incumbent workers in remote areas.

Credentialing Review and Outreach

- A search of RRCC's past program students conducted by its career coach resulted in the identification of many students who either had earned a credential but did not apply for one or had stopped taking courses only a few credits shy of earning a credential. Active outreach to those former students expanded the number of individuals with WQM credentials granted by the school. This was a major change from the historic tradition in which applying for a certificate or degree fell completely on the student. This activity inspired a policy change at RRCC, which has now institutionalized an automated certification system for all CTE programs. It follows, then, that the same review, outreach strategy and possibly policy change would help other colleges expand the pool of credentialed graduates for their respective industries.

Career Coaching

- The industry employers who interacted with a career coach found the coach provided very helpful assistance to students and helped to foster a link between themselves and the colleges. They specifically cited the positive effects of coaching with regard to student recruitment, job preparedness, and the coordination of internships. As one employer said, career coaches are very good at preparing students "*to at least make a positive image when faced with employers.*"

Career Fairs and Rodeos

- PCC has found that cohosting job fairs with local workforce centers is a successful strategy that reduces duplication of efforts and resources.
- Career/job fairs were mentioned by employers as a good recruitment strategy. Some were willing to volunteer their time to meet with college students, high school students, and their parents.
- TSJC's line tech rodeo has been a very successful strategy for keeping the industry informed of the training students receive in their program and for enabling employers to observe graduating students' skills and knowledge. Employers frequently identify top students and interview them for job openings immediately after they have performed at the event.

Active Alumni Networks

- NJC has established an active alumni network among its wind energy graduates. Alumni have provided helpful classroom workshops, advised faculty on changes in the industry, and facilitated the donation of equipment and supplies from their respective employers. This strategy would work well in other fields across the energy colleges.

Incumbent Worker Training

- To reduce costs and engage industry personnel in incumbent worker trainings, use employers' on-site resources, such as their internet connections, training rooms, and field-based equipment.
- To the extent that it is feasible, provide on-site incumbent worker training sessions that are tailored to the specific needs of a company and are scheduled around employee shifts. This approach reduces or eliminates changes to the production process, reduces the use of employees' personal time, and reduces companies' costs associated with paying for overtime and travel.

- Incumbent worker training programs, including apprenticeships, facilitate the credentialing of workers who may lack industry-recognized certificates while also providing opportunities for employees to earn college credits and degrees. Such practices may help sustain college programs as well as encourage a more stable workforce—companies that invest in their employees may reap a sense of loyalty from those workers.

Collaborative Partnerships between Educational Institutions and Professional Organizations

- FRCC's agreement with Colorado State University (CSU), a four-year institution, has resulted in an expansion of the FRCC energy program and has enabled some cost sharing between the schools. Furthermore, associate-degree students now have a greater opportunity to matriculate into four-year degree programs at CSU.
- During the grant period, TSJC joined the Center for Energy Workforce Development, a nonprofit organization that includes industry employers, educational institutions, and governmental agencies working together "to focus on the need to build a skilled workforce pipeline that will meet future industry needs."[29] It is a resource for sharing best practices and industry news, and as such it expands the college's access to curriculum and industry resources. In the future, membership in the organization may also increase the national visibility of TSJC's two line-tech programs—potentially fostering the recruitment of new students.
- Individual energy programs should extend communication beyond their own college's advisory board to engage with their counterparts at other educational institutions for the purposes of learning about and sharing promising and successful practices for training future workers in their specific industries. Topics of interest could include recruitment, curriculum, internships, and/or apprenticeship programs.
- Programs that offer stackable certificates, such as Aims certificates in oil and gas technologies and RRCC's WQM program, are appreciated by employers.
- Colleges and industry partners should explore additional resources for student and incumbent worker trainings, including the use of professional organizations and other industry employers. For example, TSJC teamed with Mountain State Line Company to provide OSHA training.

[29] Center for Energy Workforce Development. (2015). *About us.* Washington, DC: Center for Energy Workforce Development. Retrieved on January 29, 2016, from http://www.cewd.org/

PART TWO: STATE-REDESIGNED ENERGY PROGRAMS: STUDENT OUTCOMES

Methodology

Over the course of the grant, EERC collected data from CCCS on behalf of the energy colleges in that system (FRCC, NJC, PCC, RRCC, and TSJC) and from Aims and CMC directly. During the first two years of the grant, data collection occurred at the end of each (federal) fiscal year (September 30). After that, data were collected every August as a result of a change in CCCS's ODS database system. Data for were queried from the CCCS listings of redesigned courses.) and were validated by the partner colleges. Unemployment wage data for student participants were matched to student numbers based upon the USDOL quarterly reported wages from first quarter of 2012 through the first quarter (Q1) of 2015

We transformed and recoded the data from CCCS colleges to faciltate the analysis of students' academic and economic outcomes. Data from the non-system schools were also transformed to match the system variable labels and values. The variables included in the data analysis are described in Appendix B.

In this section we examine energy student outcomes from fall 2012 to fall 2014. First, we focus on the entire pool of participants in credit-bearing[30] programs—those who took part in a grant-funded certificate or degree program and enrolled in at least two redesigned energy courses for college credit—and their relation to the following program outcomes: earning certificates or degrees, education and employment retention, and wage increases. Next, we narrow our focus by limiting our population of interest to program completers—students who completed energy certificates or degrees—and their relation to the same set of program outcomes.

Certain indicators are time sensitive, including many of those related to academic terms and wages. For example, with post-credential employment or employment retention, and wages, our analysis is limited by time censoring. At the time of writing, we only had access to wage data through Q1 2015; as a result of this—and of the delays inherent in that wage data—some students completing the program in later terms fell beyond our observation.

This report also includes a comparative analysis using a cohort comprised of unique students who were enrolled in similar programs in each of the energy schools prior to redesign. We limited the comparison cohort to students enrolled in those courses between spring 2009 and spring 2011 so that the sample would not include students whose outcomes were affected by the redesigned program courses. To ensure that the two cohorts are well matched in terms of demographic characteristics such as gender, age, ethnicity, academic status, and employment

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[30] Unfortunately, restricting our pool to only those registered in credit-bearing programs meant that the 132 participants enrolled in the non-credit-bearing programs at PCC were excluded from this analysis. The move was necessary, however, because data on non-credit students did not include all the data points our analysis required. We include a series of tables containing data on these excluded participants in Appendix D.

status, the students in both groups were compared using propensity score matching (PSM). Though we are not able to conduct an experimental design, PSM helps to control for any selection bias that may have influenced any results that emerge before the two populations were demographically aligned.

It should also be noted that due to factors including time and the number of students in our samples many of these findings warrant further inquiry and investigation and should be read with that in mind.

Profile of the State-Redesign Cohort

During the reporting period, which ranges from fall 2012 to fall 2014, a total of 847 unique participants were enrolled in at least two redesigned energy courses. This group includes only those students enrolled in a credit-bearing energy program, meaning they were enrolled in at least two redesigned, credit-bearing energy programs during the reporting period. We chose to focus on students who enrolled in at least two redesigned energy courses based on the logic that enrollment in more than one course is an indicator that those students' purpose in engaging with the energy program was to receive an award (credential) of some kind rather than, for example, to take a "refresher course" or to acquire a new skill. Figure 1 shows the distribution of unique participants at the six energy schools that offered credit-bearing certificates and/or AAS degrees. RRCC has the largest share of unique students in this analysis, constituting 33 percent of the total cohort population. It is followed by Aims, which contributes an additional 28 percent to the total number of students in this group.

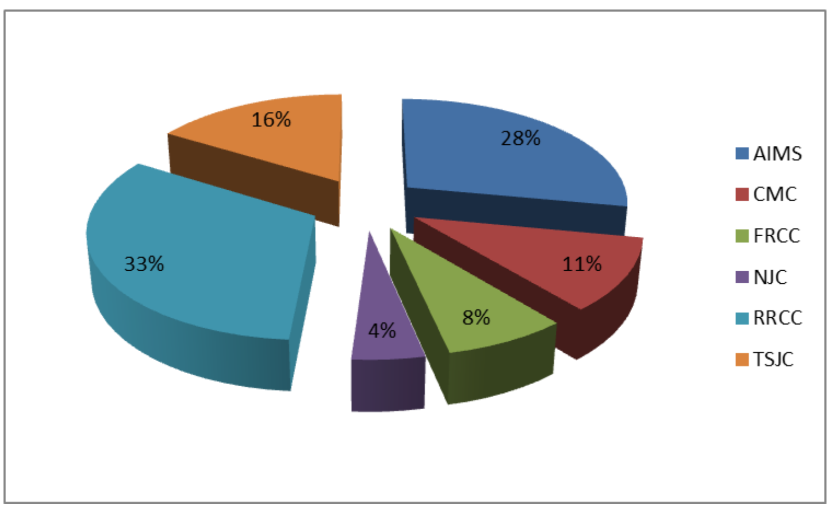

Figure 1. Proportion of Students in the State-Redesign Cohort Enrolled in Credit-Bearing Programs at Each Energy School, Fall 2012 to Fall 2014

The percentage distribution reflects when colleges implemented their redesigned courses and programs, the length (short- and long-term) of the credentials, and the size of the program at each college. To capture variations in program design and implementation, Table 2 presents the terms in which students first earned a credential in a grant-redesigned energy program. It should be noted that the table includes only energy credentials such as an AAS or certificates. Because of this, the numbers in the Total column reflect only those students who earned an energy certificate or degree over the course of the study period, not the number of students enrolled in each program.

Table 2. CREDENTIALS EARNED AND FIRST TERM IN WHICH CREDENTIAL WAS GRANTED BY COLLEGE AND PROGRAM

Completers by Term Redesigned Energy Program of Study		Total	Fall 12	Spring 13	Summer 13	Fall 13	Spring 14	Summer 14	Fall 14	Spring 15
Aims Community College		51								
101	Oil and Gas Technologies AAS	10							5	5
102	Industrial Technology AAS	3					1			2
103	Intro to Oil and Gas Technologies Certificate	34	3		3	6	8		5	9
104	Oil and Gas Production Tech Certificate	1								1
105	Industrial Technology Level 1 Certificate	2		1				1		
106	Industrial Technology Level 2 Certificate									
107	Industrial Technology Level 4 Certificate	0								
108	Industrial Technology Level 3 Certificate	0								
108	Engineering Tech Certificate	1							1	
Colorado Mountain College		20								
201	Process Technology AAS	17	2	3	2	2	4		4	
202	Petroleum Technology Certificate	0								
203	Industrial Instrumentation Controls Certificate	0								
204	Photovoltaic Installation Certificate	2		1					1	
205	Basic Solar Photovoltaic Certificate	1							1	
Front Range Community College		17								
301	Electro-Mechanical and Energy Technology AAS	7					7			
302	Electro-Mechanical and Energy Technology Certificate	10		3			2		2	3
Northeastern Junior College		9								
401	Wind Energy Technician AAS	9		2	5	2				
402	Wind Technician Core Certificate	0								
403	Summer Intensive Wind Technician Certificate	0								
Red Rocks Community College		128								
601	Water Quality Management AAS	59	3	18	2	3	9	2	7	15
602	Laboratory Analysis Certificate	13	1	3	2		3			4
603	Distribution and Collection Training Certificate	7			2	1	4			
604	Education and Experience Certificate	0								
605	Mathematics in Water Quality Certificate	23	5	2	3		5			8

606	Introduction to Wastewater Treatment Certificate	11		1		2	2	1	4	1
607	Introduction to Water Treatment Certificate	15		12			1		2	
608	Advanced Water Treatment Certificate	0								
609	Source Control and Water Audit Certificate	0								
610	Advanced Wastewater Treatment Certificate	0								
TSJC		108								
701	Southern Colorado Line Technician AAS	0								
702	Southern Colorado Line Technician Certificate	0								
703	Rocky Mountain Lineman Technician Certificate	108	23	20		21	20		24	
704	Rocky Mountain Lineman Technician AAS	0								

Table 2 indicates that only FRCC credentialed students in every one of the redesigned programs it offered through the grant. It should be noted, however, that students completed the majority of the redesigned programs offered at almost every school in the study. In terms of the number of students completing a redesigned program, RRCC had the highest number of students earning a certificate or AAS (128); it was followed by TSJC (108).

Program Completion

As mentioned above, 847 students met our criteria for inclusion in this report as *program participants*, Of the total number of program participants in our study, 333 are further classified as *program completers*—students who completed their programs by earning a certificate, degree, or both prior to Spring 2015, the last term for which data is available.[31] Thus, 39 percent of the program participants considered in our study completed a program. The data displayed in Tables 3 and 4 indicate that completion rates varied across schools (RRCC and TSJC had substantially higher completion rates than did the rest of the colleges in the study likely due to the cohort model of their program) as well as across different types of programs—since certificates take less time to earn than degrees, for example, the higher rates of completion at RRCC and TSJC might be explained by the fact that more certificate programs are offered at these schools, and that RRCC offered opportunities for students to stack certificates.

[31] Our final data collection for this report occurred before the sunset date of the grant (September 30, 2015), so the total number of students completing credentials during the course of the grant is likely to be higher than we are able to report here.

Table 3. NUMBER AND PERCENTAGE OF PROGRAM COMPLETERS

School	Number of program participants	Number of program completers	% of participants completing a program
Aims	237	51	22%
CMC	93	20	22%
FRCC	65	17	26%
NJC	38	9	24%
RRCC	276	128	46%
TSJC	138	108	78%
Total	**847**	**333**	**39%**

As mentioned above, program completers tended to differ with respect to the type of program or type of credential(s) earned. Overall our data set contains more certificate earners (short and medium certificates) than AAS earners. Across all the colleges there were approximately four certificates earned for every AAS degree earned. For this reason, the total number of credentials granted by a school reveals only part of the overall picture. A large number of students at both RRCC and TSJC, for example, were certificate earners compared to other schools. Yet while the population of students at RRCC was earning both certificates *and* degrees, possibly through the stacking of credentials by individual students, those enrolled at TSJC earned only certificates—no degrees were granted by TSJC during the study period. This may be a result of changes in staffing at TSJC which influenced the AAS program or it could result from time constraints. To understand the differences between these energy programs, then, it is important to take into account not only *how many credentials* they granted but also exactly *which credentials* they were. To this end, Table 3 presents the types of credentials earned by students within each school as well as the number of students earning these credentials.

Examining the ratio of credentials to students, which compares the number of credentials awarded by a program to the number of students receiving credentials from that same program, allows us to develop more nuanced insights into each program. While a single credential (such as a certificate or degree) can be earned by multiple students, it is also possible for a single student to earn multiple credentials. A higher ratio might therefore indicate programs that are popular with overachieving students (since few students earned multiple credentials)—and thus perhaps a strengthening field of talent for employers in those fields—or schools that were able to create better opportunities for more diversified programs.

Table 4. TYPES OF REDESIGNED CREDENTIALS EARNED, BY COLLEGE

School	Short certificate (≤1 year)	Medium certificate (>1 year but ≤2 years)	AAS degree	Total credentials	Number of students earning credentials	Ratio of credentials to students
Aims	0	53	13	66	51	1.29
CMC	7	4	17	28	20	1.40
FRCC	0	16	7	23	17	1.35
NJC	0	0	9	9	9	1.00
RRCC	241	0	59	300	128	2.34
TSJC	108	0	0	108	108	1.00
Total	**356**	**73**	**105**	**534**	**333**	**1.60**

It should also be noted that the credentials-to-students ratio will vary depending on the nature of the programs offered by a given school, particularly with regard to the average number of credit hours that are required to complete the certificates offered by the school. F or example, RRCC, which has the highest ratio of credentials to students, offers a variety of short-certificate programs—those with the least amount of credit hours required for completion. In fact, of the nine energy programs offered at RRCC, eight are certificate programs requiring an average of only six credit hours to complete—the lowest time-to-credential we encountered across the colleges.[32] Thus, the variety of short programs offered at RRCC creates more opportunities for students to stack credentials. Additional as mentioned above RRCC also employed tactics to seek out students who had earned a credential but had not applied for it. This activity and policy change resulted in more awarded certificates.

Tables 5 and 6 provide a closer look at the phenomenon of credential stacking. In Table 5, we break down the number of AAS completers at each school according to how many additional credentials (certificates) those students earned. We see that of the 105 AAS degrees earned, the majority were earned at RRCC (59), followed by CMC (17) and Aims (13). More than half of all students earning AAS degrees also completed additional certificates. In three out of the five colleges where AAS degrees were earned, the majority of AAS completers earned at least one certificate in addition to their degree. Remarkably, at RRCC, three students earned five certificates in addition to their AAS degree. The awarding of these additional certificates was a result of the RRCC career coach actions. She reviewed all students' records – and realized that a number of students had in fact had completed all requirements for additional certificates. She then actively helped these students apply for the additional certificates.

[32] See Appendix C for detailed information on each of the energy programs.

Table 5. STACKING OF REDESIGNED CERTIFICATES BY UNIQUE AAS DEGREE PROGRAM COMPLETERS BY COLLEGE

School	Total of AAS degrees granted	Students earning AAS only	Students earning AAS + 1 Certificate	Students earning AAS + 2 Certificates	A Students earning AAS + 3 Certificates	Students earning AAS + 4 Certificates	Students earning AAS + 5 Certificates
Aims	13	4	4	5	0	0	0
CMC	17	11	6	0	0	0	0
FRCC	7	1	6	0	0	0	0
NJC	9	9	0	0	0	0	0
RRCC	59	21	3	12	9	11	3
TSJC	0	0	0	0	0	0	0
Total	**105**	**46**	**19**	**17**	**9**	**11**	**3**

Table 6 provides data on credential stacking for all program completers, not just degree earners. It shows that, of all 429 certificates earned across the energy colleges during the study period, the majority—241—were earned at RRCC, which accounted for 56 percent of the total certificates earned. Most of those credentials were granted to students who earned more than one certificate. An additional 108 certificates were earned at TSJC, but at that school, all of those certificates were earned by unique students (single-certificate earners). This contrast found among the top two certificate-granting schools in our study is likely due to the fact that the two redesigned certificate programs offered at TSJC require more credit hours to be completed—35 hours on average—compared to those at other colleges, whereas those offered by RRCC tend to require far fewer.

Most (72 percent) of the students across all the colleges are single-certificate earners. This is evident in the ratios, shown in Table 6, of certificates earned to students; with the exception of RRCC, those ratios are close to one.

Table 6. NUMBER OF REDESIGNED ENERGY CERTIFICATES EARNED BY UNIQUE STUDENTS BY COLLEGE

School	Total certificates earned in energy program	Total number of students earning certificates	Single-certificate earners	Dual-certificate earners	Three-certificate earners	Four-certificate earners	Five-certificate earners	Ratio of certificates earned to students
Aims	53	47	41	6	0	0	0	1.13
CMC	11	9	7	2	0	0	0	1.22
FRCC	16	16	16	0	0	0	0	1.00
RRCC	241	107	35	30	26	12	4	2.25
TSJC	108	108	108	0	0	0	0	1.00
Total	**429**	**287**	**207**	**38**	**26**	**12**	**4**	**1.49**

Demographic Profile of State-Redesign Program Completers by College

Prior to discussing program outcomes it is necessary to examine how program completers vary with regard to different demographic variables available in our data set. These variations will be explored using either a contingency analysis or by comparing differences in means. It is important to note that looking at the profile of completers by school will reduce our sample sizes; in some cases, this could lead to biased results.

Overall assessments of the profile of the completers indicate that they were more likely to be concentrated in certain schools and enrolled in certificate (one term programs). For example, the percentage distribution of completers was higher in RRCC (38 percent), TSJC (32 percent), and Aims (15 percent) than in other schools. Completers also tended to be students who were eligible for Pell grants, and they were more likely to be unemployed than to be incumbent workers.

Table 7 shows the gender distribution of program completers. Since the vast majority of energy students were male (82 percent), it follows that males also made up the majority (84 percent) of students who earned either a certificate or degree. The fact that males represented a majority of completers across the colleges is not surprising, as energy is a male-dominated field. This uneven distribution does not mean that males tended to complete their programs at a higher rate than females did, however. This is because we are looking at the percentage distribution of completers alone—independent of non-completers. For example, even though 84 percent of the completers were male students, males also made up 81 percent of the population of program participants who did *not* complete degrees. At the same time, although females constituted only 16 percent of all degree completers, they also accounted for only about 19 percent of non-completers. We see, then, that both genders were about equally likely to complete their credentials once they enrolled in an energy program. Looking across all schools, the contingency analysis confirmed this finding; the chi-squared value of 1.43 is not statistically significant ($p > 0.005$). We found, however, that at TSJC specifically, males had higher completion rates than females did. Still, while that difference was statistically significant, it was not found to have an appreciable real-world effect. (The chi-squared value of 7.44 was statistically significant at $p < 0.005$ but had an effect size of 0.23, which is considered small.[33]). The large enrollment disparity of men and women in energy programs is of a real concern, and may reflect cultural perceptions and attitudes, hiring practices and college recruitment efforts. EERC suggests that our findings affirming the lack of gender differences in completion dates be used in future recruitment efforts.

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[33] Throughout this analysis, effect sizes are categorized as small, moderate, and large according to Cohen's system of classification. (Cohen, J. [1988]. *Statistical power analysis for the behavioral sciences.* Hillsdale, NJ: Erlbaum.)

Table 7. DISTRIBUTION OF PROGRAM PARTICIPANTS, PROGRAM COMPLETERS, AND COMPLETERS-PER-COLLEGE BY GENDER

Gender	All energy students	All completers	Aims	CMC	FRCC	NJC	RRCC	TSJC
Male	82%	84%	77%	80%	88%	100%	74%	98%
Female	18%	16%	24%	20%	12%	0%	26%	2%
Total	**845**	**333**	**51**	**20**	**17**	**9**	**128**	**108**

Looking at age—which we separated into two categories: those under 25 years old and those 25 years and over —we see that while nontraditional students (those 25 years and over) accounted for the majority of all completers, they also accounted for the majority of energy students overall. As shown in Table 8, 65 percent of all program completers were nontraditional students. Looking across colleges, nontraditional students held a majority over traditional students among those who completed programs at RRCC (87 percent), CMC (70 percent), FRCC (59 percent), and TSJC (52 percent). Aims and NJC were the only schools where traditional students made up a greater proportion of the credential-earning population than their nontraditional counterparts did.

As noted earlier with regard to gender, however, the higher proportion of nontraditional students represented among degree earners do not necessarily translate to a higher rate of completion among those students. In fact, the contingency analysis did not reveal any statistically significant difference between traditional and nontraditional students in terms of overall completion rates. When looking at the association between program completers and age across the individual colleges, we found statistically significant associations between age and program completion only at Aims and TSJC. At Aims, while 57 percent of completers were under 25, traditional students accounted for only 37 percent of non-completers. In contrast, while 43 percent of the completers at Aims were 25 years and over, nontraditional students made up about 62 percent of non-completers ($\chi^2 = 6.08$; $p = 0.014$). Still, the small effect size of this association (0.16) indicates that it may have little practical value. The association found at TSJC ($\chi^2 = 23.18$; p = 0.000), on the other hand, had a moderate effect size of 0.41, implying that traditional students at that school may have some real advantage over nontraditional students with regard to program completion. At TSJC 48% of all program completers were under 25 and 52% were over 25. However, if we look at non-completers, none of them were under 25, which indicate a higher variability among the non-traditional students in terms of completion. As such even though non-traditional students comprised a higher percentage of completers, they also constituted all of TSJC's non-completer students.

Table 8. : DISTRIBUTION OF PROGRAM PARTICIPANTS, PROGRAM COMPLETERS, AND COMPLETERS-PER-COLLEGE BY AGE

Age	All energy students	All completers	Aims	CMC	FRCC	NJC	RRCC	TSJC
Under 25	35%	35%	57%	30%	41%	56%	13%	48%
25 and over	65%	65%	43%	70%	59%	44%	87%	52%
Total	**847**	**333**	**51**	**20**	**17**	**9**	**128**	**108**

Before we examine our population of program completers within categories of race (shown in Table 9), we should note that the sample sizes were very small within some of these categories. Because of this, the findings from the contingency analysis are likely to be biased, as the values in many cells fell below the minimum required for an accurate reading. This requirement was further violated when we broke down the sample even further to conduct our analysis by college. Therefore, the results that follow should be read with caution.

Our contingency analysis indicates that race is associated with completers in a way that is statistically, though not practically, significant ($\chi^2 = 16.56$; $p = 0.002$; effect size = 0.14). Table 9 indicates that across all colleges, the majority of completers were white (75 percent), followed by Hispanic (18 percent).

Table 9. DISTRIBUTION OF PROGRAM PARTICIPANTS, PROGRAM COMPLETERS, AND COMPLETERS-PER-COLLEGE BY RACE

Race	All energy students	All completers	Aims	CMC	FRCC	NJC	RRCC	TSJC
White	75%	81%	52%	78%	80%	86%	87%	89%
Black	4%	3%	4%	0%	7%	0%	5%	1%
Hispanic	18%	12%	42%	17%	0%	14%	4%	8%
Asian or Pacific Islander	1%	1%	2%	N/A	7%	0%	1%	1%
American Indian/Alaska Native	2%	3%	N/A	6%	7%	N/A	3%	2%
Total	**800**	**315**	**50**	**18**	**15**	**7**	**119**	**106**

Table 10 breaks down the population of program participants and completers in terms of ethnicity, operationalized here as Hispanic and non-Hispanic.[34] Hispanic students constituted 17 percent of all program participants and accounted for only 11 percent of all program completers. The proportion of Hispanic completers ranged widely across the colleges, from 0 percent at FRCC to as many as 41 percent at Aims. Ethnicity and completers were found to be associated in a way that was statistically significant but lacking in practical value ($\chi^2 = 12.15$;

[34] According to the US Census, Hispanic is "viewed as heritage, nationality, lineage, or country of birth of the person or the person's parents or ancestors before arriving in the United States." Individuals of Hispanic origin can be of any race. (US Census). "Race" a social construction is therefore separated from Hispanic.

p = 0.000; effect size = 0.12). When breaking down ethnicity by individual colleges,[35] we find a statistically significant association only at RRCC.

Table 10. DISTRIBUTION OF PROGRAM PARTICIPANTS, PROGRAM COMPLETERS, AND COMPLETERS-PER-COLLEGE BY ETHNICITY

Ethnicity	All energy students	All completers	Aims	CMC	FRCC	NJC	RRCC	TSJC
Non-Hispanic	83%	89%	59%	85%	100%	89%	96%	93%
Hispanic	17%	11%	41%	15%	0%	11%	4%	7%
Total	**847**	**333**	**51**	**20**	**17**	**9**	**128**	**108**

We found that Pell grant eligibility (an indicator of economic disadvantage) was significantly associated with program completion (χ^2 = 14.40; p = 0.000), but the association's effect size of 0.13 is considered small according to Cohen's classification.[36] Table 11 indicates that among all the completers, 69 percent were not eligible for a Pell grant while 32 percent were eligible. Comparatively, among the non-completers, 80 percent were Pell-eligible while 20 percent were not.

Table 11. DISTRIBUTION OF PROGRAM PARTICIPANTS, PROGRAM COMPLETERS, AND COMPLETERS-PER-COLLEGE BY PELL ELIGIBILITY

Pell Status	All energy students	All completers	Aims	CMC	FRCC	NJC	RRCC	TSJC
Not Eligible	75%	69%	100%	10%	65%	56%	62%	74%
Eligible	25%	32%	N/A	90%	35%	44%	38%	26%
Total	**847**	**333**	**51**	**20**	**17**	**9**	**128**	**108**

Incumbent Workers: Employment and Wages

The energy sector is the third most important sector in Colorado after information technology and financial services.[37] In general, the sector has been an expanding one.[38] However, the energy sector across the nation and in Colorado, has experienced fluctuations in the past few years impacted by the Great Recession; the sun setting of the Renewable Energy Production Tax Credit (PTC) (affecting employment in wind, solar, and a smart grid industries)[39] and shifting

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[35] The cell size of the other ethnicities were too small to be included.

[36] Cohen (1988), op. cit.

[37] Colorado Energy Coalition. (Dec 2013). Resource Rich Colorado: Colorado's National and Global Position in the Energy Economy. Accessible at www.metrodenver.org

[38] BCS Incorporated. (Nov. 2013). Colorado's Energy Industry: Strategic Development through Collaboration. Accessible at www.colorado.gov

[39] American Wind Energy Association. Federal Production Tax Credit for Wind Energy.

demand in the oil and gas industries. The discussion below thus needs to be viewed within this context.[40]

Incumbent workers are defined as those students who were employed at the time of their first enrollment in a redesigned program course. [41] About 33 percent of program completers were incumbent workers (n=110). Comparing the employment status of program completers by the type of credential earned, we notice that incumbent workers comprised about 37 percent of all students earning AAS degrees compared to only 32 percent of those who earned certificates. NJC reported the highest percentage of incumbent workers—56 percent—followed by Aims with 51 percent. FRCC (24 percent) and CMC (25 percent) reported the lowest percentages of incumbent workers completing their energy programs. At Aims, those earning an AAS constituted the majority of incumbent workers (75 percent). This was not the case at FRCC, where a higher percentage of incumbent workers were certificate earners.

When reporting wages, it should be noted that our Unemployment Insurance (UI) data covers student wages starting in the first quarter of 2012 up until the first quarter of 2015. Similarly, when counting awards, we were only able to follow students through spring 2015. Due to the lagged nature of both wage and term-completion data, this means that, in reality, we were only able to include student wages and credentials earned through fall 2014. Degrees or certificates that were conferred in spring 2015 were excluded because at the time of writing, spring 2015 data was not yet available. Likewise, wage data was not available beyond Q1-2015. Additionally, the information available to us in the UI data set does not allow us to determine whether those employed were working full or part time. Finally, it should be noted that the data available to us does not provide information on the field of work in which students were employed.

In calculating the employment indicator we use the student's wages earned in the term (and the respective quarter in which it falls) in which the student first enrolled in a TAACCCT redesigned energy program. This becomes the student's pre-completion or base wage. We then compare this base or equivalent quarter with the student's wages in the first two quarters subsequent to his/her earning a degree or certificate. As an example, if a student first enrolled in a redesigned course fall 2012, the pre-completion wage is quarter 3 (July to September 2012). If a student did not have wage in the pre-completion base quarter, he/she was deemed a non-incumbent worker and is not included in the analysis. Table 12, indicate that most incumbent workers saw an increase in wages after completing a credential regardless of which credential they earned or where they earned it. Among all incumbent workers who were employed after

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Accessible at http://www.awea.org/Advocacy

[40] See EERC's COETC Interim Energy report for further discussion of employment and wage trends in the energy sector.

[41] Note that "employment" does not imply that the student was working in the same field as his or her field of study but simply that the student was working for wages at the time of enrollment in his/her first redesigned (or historic equivalent) energy course. Furthermore, employment at the end of a program of study also does not imply that the student was working in his or her field of study.

completion, the average post-completion quarterly increase in wages was $2,949. The average wage increase fluctuated across schools, however: Students at NJC and TSJC saw the highest increases in wages post-completion ($7,516 and $4,482, respectively), and students at CMC saw the most modest increase ($474)[42]. Looking across the type of credentials earned, those who earned an AAS enjoyed almost twice the quarterly wage increase than those earning a certificate alone—the average post-completion increase was $4,840 for degree earners vs. $2,772 for certificate earners.

To understand if there was a statistically significant difference in incumbent workers' average wages pre- and post-completion, we ran a paired sample t-test, which compares the average of a pair of two continuous variables. We found the difference in means to be statistically significant ($t[85] = 5.563$; $p = 0.000$), indicating an improvement in average wages post-completion for incumbent workers. We also ran tests of the analysis of variance to look at the differences in average wages pre- and post-completion 1) among the three types of completers (AAS alone, certificate alone, or AAS and certificate) and 2) among the six energy colleges in the study. No statistically significant differences emerged in these analyses. However, both analyses were subject to bias due to the relatively small number of program completers. For example, when the overall sample was broken down by type of credential earned, the sample of AAS-only completers contained only 11 students, and the sample for AAS-and-certificate completers contained just 17. Such samples are simply not large enough to make a reliable comparative analysis possible and should be taken into account when looking at increases and decreases in wages.

About 78 percent of all incumbent workers were employed post-completion, but that number varied from school to school. At NJC, 100 percent of the incumbent workers were employed post-completion, while at Aims, only 46 percent were employed. The marked decrease in the employment retention of incumbent workers at Aims seems to be an anomaly, however; at RRCC and TSJC, about 88 percent and 90 percent of incumbent workers were employed post-completion, and more than half of incumbent workers at CMC and FRCC also remained employed. Interestingly, across categories of credential earners, employment was lowest among incumbent workers who completed only an AAS and highest among AAS-plus-certificate completers (65 percent vs. 85 percent).

[42] Please note from table 11 that due to a small sample size these numbers should be viewed with caution

*Table 12. WAGE ANALYSIS OF INCUMBENT WORKERS**

Completer Types by School	Total Completers	Number of Incumbent Worker Completers	% of Incumbent Worker Completers	Incumbent Worker Completers Employed at Time of Completion	Mean Quarterly Wages of Incumbent Worker Completers at Start of Program	Mean Quarterly Wages of Incumbent Worker Completers Who Were Employed after Completion	Difference in Mean Quarterly Wages for Incumbent Workers
Aims	**51**	**26**	**51%**	**12**	**$5,121.77**	**$6,384.66**	**$1,262.89**
AAS-only Completer	4	3	75%	0	$9,249.04		
Cert-only Completer	38	18	47%	9	$5,086.91	$6,790.99	$1,704.09
AAS-and-Cert Completer	9	5	56%	3	$2,770.92	$5,165.68	$2,394.76
CMC	**20**	**5**	**25%**	**4**	**$3,191.40**	**$3,665.25**	**$473.85**
AAS-only Completer	11	4	36%	3	$3,391.25	$4,847.00	$1,455.75
Cert-only Completer	3	1	33%	1	$2,392.00	$120.00	($2,272.00)
AAS-and-Cert Completer	6	0	0%	0			$0.00
FRCC	**17**	**4**	**24%**	**3**	**$5,317.17**	**$8,170.79**	**$2,853.62**
AAS-only Completer	1	0	0%	0			
Cert-only Completer	10	2	20%	1	$4,066.50	$1,093.02	($2,973.48)
AAS-and-Cert Completer	6	2	33%	2	$6,567.85	$11,709.68	$5,141.84
NJC	**9**	**5**	**56%**	**5**	**$2,809.86**	**$10,326.09**	**$7,516.23**
AAS-only Completer	9	5	56%	5	$2,809.86	$10,326.09	$7,516.23
Cert-only Completer	0	0		0			
AAS-and-Cert Completer	0	0		0			
RRCC	**128**	**40**	**31%**	**35**	**$7,547.33**	**$9,550.96**	**$2,003.63**
AAS-only Completer	21	5	24%	3	$11,728.25	$20,279.39	$8,551.14
Cert-only Completer	69	22	32%	20	$7,079.81	$8,619.27	$1,539.46
AAS-and-Cert Completer	38	13	34%	12	$6,730.49	$8,421.67	$1,691.18

TSJC	**108**	**30**	**28%**	**27**	**$3,136.20**	**$7,618.44**	**$4,482.24**
AAS-only Completer	0	0		0			
Cert-only Completer	108	30	28%	27	$3,136.20	$7,618.44	$4,482.24
AAS-and-Cert Completer	0	0		0			
Total	**333**	**110**	**33%**	**86**	**$5,276.55**	**$8,225.60**	**$2,949.05**
AAS-only Completer	46	17	37%	11	$6,706.04	$11,546.33	$4,840.29
Cert-only Completer	228	73	32%	58	$4,820.97	$7,593.37	$2,772.40
AAS-and-Cert Completer	59	20	34%	17	$5,724.33	$8,233.91	$2,509.58

NOTE: Post-completion wage based on UI data from second quarter after completing a credential.

Non-Incumbent Workers: Employment and Wages

We now turn our attention to non-incumbent workers and their post-completion employment and wages (See Table 13). In general, post-completion employment rates were much lower for non-incumbent workers than they were for incumbent workers. For example, across all the colleges, only 17 percent of non-incumbent workers were employed within two quarters of earning their credential compared to 78 percent of incumbent workers. This relationship remained when we examined the colleges individually as well, though the size of the gap between the two groups fluctuated considerably. At Aims, the contrast was negligible: 44 percent of non-incumbent workers were employed compared to 46 percent of incumbent workers. At NJC, on other hand, none of the non-incumbent workers were employed, whereas 100 percent of the incumbent workers were employed.

The average wage of all non-incumbent completers employed within two quarters of receiving their credential was $6,385. Those who earned an AAS degree alone earned around $5,211, while the average wage of those with only a certificate was $6,974. The average post-completion wage for non-incumbent workers was highest at Aims ($8,383), RRCC ($8,317), and TSJC ($7,817), and it was lowest at CMC ($2,699). When comparing the aggregated post-completion wages for all incumbent completers in the study with those of all non-incumbent completers, we see that completers who were incumbent workers had higher wages on average. This difference is greater among AAS-only completers ($6,355) than it is among both certificate-only completers ($650) and AAS-and-certificate completers ($2,434).

We should note here that the sample of students per cell was generally small when broken down across colleges, and those small sample sizes make comparison biased. For example, we only received post-completion wage data for 38 non-incumbent completers. Once those 38 cases were broken down by type of credential, there were only 5 students categorized as AAS-only completers and 11 students categorized as AAS-and-certificate completers. So even though we see differences in the average wage for each type of credential as well as for each college, the sample does not provide enough data to inspire confidence in such a finding.

Table 13. WAGE ANALYSIS OF NON-INCUMBENT WORKERS*

Completer Types by School	Total Completers	Number of Non-incumbent Worker Completers	% of Non-incumbent Worker Completers	Non-incumbent Worker Completers Employed at Time of Completion	Mean quarterly Wages of Non-incumbent Worker Completers Who Were Employed after Completion
Aims	**51**	**25**	**49%**	**11**	**$8,383.34**
AAS-only Completer	4	1	25%	0	
Cert-only Completer	38	20	53%	9	$7,546.90
AAS-and-Cert Completer	9	4	44%	2	$12,147.30
CMC	**20**	**15**	**75%**	**12**	**$2,698.75**
AAS-only Completer	11	7	64%	4	$3,522.00
Cert-only Completer	3	2	67%	2	$679.00
AAS-and-Cert Completer	6	6	100%	6	$2,823.17
FRCC	**17**	**13**	**76%**	**1**	**$5,574.75**
AAS-only Completer	1	1	100%	0	
Cert-only Completer	10	8	80%	0	
AAS-and-Cert Completer	6	4	67%	1	$5,574.75
NJC	**9**	**4**	**44%**	**0**	
AAS-only Completer	9	4	44%	0	
Cert-only Completer	0	0		0	
AAS-and-Cert Completer	0	0		0	
RRCC	**128**	**88**	**69%**	**6**	**$8,316.94**
AAS-only Completer	21	16	76%	1	$11,968.07
Cert-only Completer	69	47	68%	3	$6,981.30
AAS-and-Cert Completer	38	25	66%	2	$8,494.81
TSJC	**108**	**78**	**72%**	**8**	**$7,817.34**
AAS-only Completer	0	0		0	
Cert-only Completer	108	78	72%	8	$7,817.34
AAS-and-Cert Completer	0	0		0	
Total	**333**	**223**	**67%**	**38**	**$6,384.65**
AAS-only Completer	46	29	63%	5	$5,211.21
Cert-only Completer	228	155	68%	22	$6,943.76
AAS-and-Cert Completer	59	39	66%	11	$5,799.82

NOTE: Post-completion wage based on UI data from second quarter after completing a credential.

Continuing Education

For the purposes of this report, *continued education* refers to a student's enrollment in another course or program in the semester immediately following the receipt of his or her first credential. Looking across all colleges, approximately 36 percent of program completers continued education at a community college after earning their first credential. Among program completers who ultimately earned only an AAS degree, about 11 percent continued education, while among those who earned both an AAS and at least one certificate, 61 percent continued their education at a community college. (This makes sense, as one might imagine that in many cases, continued education on the part of AAS-only recipients would have resulted in the completion of a certificate, thus moving that student out of the category of "AAS-only earner" and into the category "AAS-and-certificate earner.") About 34 percent of certificate-only earners continued education at a community college. We observed the highest retention rate at RRCC (57 percent), followed by FRCC (53 percent) and Aims (41 percent). The lowest retention rates were found at NJC (0 percent), TSJC (12 percent), and CMC (15 percent). The reason for NJC could be due to a small number of students earning credentials but also due to the number of credentials offered by the school. NJC for example, while NJC offered certificates and an AAS degree in wind technologies only associate degrees were earned during the grant cycle. There may have been students who went on to study at other institutions.

We also ran contingency analyses of continuing education across categories of credentials earned and across colleges to see if any significant associations emerged (Table 14). We found that continuing education bears a statistically significant association with credential type ($\chi^2 = 29.03$; $p = 0.000$). This association has a small-to-moderate effect size of 0.30.[43] Among all program completers in the study, 11 percent of AAS-only completers, 34 percent of certificate-only completers, and 61 percent of AAS-and-certificate completers continued their education. This may be inherent in stacking credentials. We also found a statistically significant association when comparing continuing education by colleges ($\chi^2 = 63.29$; $p = 0.000$). The effect size for this association was 0.44, which is still moderate but is slightly stronger than the effect size of the association found between continuing education and credential type.

[43] Cohen (1988), op. cit.

Table 14. CONTINUED EDUCATION BY TYPE OF COMPLETER BY COLLEGE

Completer Types by School	Total Completers	Completers Retained in Education	Percentage of Completers Retained in Education
Aims	**51**	**21**	**41%**
AAS-only Completer	4	2	50%
Cert-only Completer	38	13	34%
AAS-and-Cert Completer	9	6	67%
CMC	**20**	**3**	**15%**
AAS-only Completer	11	0	0%
Cert-only Completer	3	1	33%
AAS-and-Cert Completer	6	2	33%
FRCC	**17**	**9**	**53%**
AAS-only Completer	1	0	0%
Cert-only Completer	10	5	50%
AAS-and-Cert Completer	6	4	67%
NJC	**9**	**0**	**0%**
AAS-only Completer	9	0	0%
Cert-only Completer	0	0	
AAS-and-Cert Completer	0	0	
RRCC	**128**	**73**	**57%**
AAS-only Completer	21	3	14%
Cert-only Completer	69	46	67%
AAS-and-Cert Completer	38	24	63%
TSJC	**108**	**13**	**12%**
AAS-only Completer	0	0	
Cert-only Completer	108	13	12%
AAS-and-Cert Completer	0	0	
Total	**333**	**119**	**36%**
AAS-only Completer	46	5	11%
Cert-only Completer	228	78	34%
AAS-and-Cert Completer	59	36	61%

Comparative Analysis: Methodology

We will now turn to the analysis of outcome indicators by including the comparison cohort of students. Our comparison cohort includes all students enrolled in selected programs at each of the energy colleges between spring 2009 and spring 2011—the period just before the energy colleges received the grant funds that allowed them to redesign their courses. To make the cohort comparisons as accurate as possible, we paired each state-redesigned program with the program that was most similar to it prior to the redesign period. In addition, to make sure that the two cohorts consist of students with the same demographic profiles, we used propensity score matching on a wide range of demographic characteristics including gender, age, ethnicity, Pell eligibility, and employment status among others.

In our analysis, we examine the effects of cohort membership (the independent variable) on program completion, employment, and continuing education rates as well as students' academic performance. Two categorical variables in the model relate to program completion. The first is a dichotomous variable that reports whether students completed a program. For those who completed a program, a related variable, credential type, reports which form of credential—certificate and/or AAS degree—was earned. Two additional variables relate to program completion; both are continuous rather than categorical. The first reports the total number of credentials earned by each student, and the second reports the number of different types of credentials earned by each student.

We also included multiple measures of employment in the model. Dichotomous variables report whether students were employed at enrollment and post-completion as well as whether their post-completion employment was retained for at least two quarters. For students who were employed at any time pre- and post-completion, a continuous measure reflects the difference in their wages between those two periods in dollars.

Continuing education is a dichotomous variable that reports whether a student enrolled in an energy course in the term immediately following the completion of his or her first credential. Finally, two continuous measures of academic performance report 1) the number of A grades students earned in their energy courses (an indicator of high achievement) and 2) the number of credits students earned in their energy courses (measured by counting the number of courses in which the student received a grade of C or better).

We began by using a combination of chi-square analysis, t-tests, and analysis of variance to generate descriptive statistics that compared students from the state-redesign and historic cohorts across the demographic and academic characteristics as well as across the outcome variables. The exact statistical test we used varied depending on the nature of the dependent variable. Following the descriptive analyses, we employed multivariate analysis methods to try to untangle the relationships between the outcome variables and different predictors. As in our descriptive analysis, which form of multivariate analysis we used—linear or logistic regression—depended on the nature of the outcome variable(s) in the model.

Comparative Analysis: Demographic Characteristics

We begin our comparative analysis by first looking at the demographics of program participants in each cohort. We report our findings as either percentages (for categorical variables) or as means and standard deviations (for continuous variables). Because our focus was on comparing the two cohorts, we were concerned only with variables that were associated with cohort membership in a way that was statistically significant; therefore, additional statistics are not reported for variables that lacked such a relationship. Table 15 shows that the two cohorts differ significantly with regard to almost all of the demographic variables in our model. For example, the state-redesign cohort contained far more male than female students, whereas the distribution of males and females in the historic cohort was more even. Still, the effect size of this difference (0.18) was small. Similarly, while there were more veterans in the historic cohort than there were in the state-redesign cohort—and more Pell-eligible students, full-time students, and incumbent workers in the state-redesign cohort than in the historic cohort—these results, too, were statistically significant but with small or negligible effect sizes. In fact, with the exception of age, all between-cohort demographic differences that emerged as statistically significant in Table 15 were found to have effect sizes that ranged from negligible to small, implying that these observed differences bore little practical significance. With regard to age, however, the statistically significant outcome was found to have a moderate effect size of .50; state-redesign students tended to be younger on average than historic-cohort students.

We should also note that the cohorts are not equal in size; the historic cohort has a comparatively larger number of program participants than the state-redesign cohort does. While this imbalance does not itself pose a threat to the analysis that follows, the uneven distribution of different demographic characteristics may bias some results given that these demographic characteristics could influence our outcome variables. For example, if we find that males were more likely to complete their energy programs than females were, and the state-redesign cohort contained a higher proportion of male students than the historic cohort did, than any results regarding program completion will be biased toward the state-redesign cohort. For the multivariate analysis, then, it will be necessary for the cohorts to be adjusted so that they are as similar as possible in terms of observable demographic characteristics such as gender and age.

Table 15. DEMOGRAPHIC PROFILE OF STATE-REDESIGN AND HISTORIC COHORT SAMPLES

Variable	State Redesign	Historic	Test statistics value*[44]	Degree of freedom	Probability value	Effect size
Program Participants	847	4409				
Gender	845	4398				
Male	*82.10%*	*58.20%*	172.572	1	0.000	0.181
Female	*17.90%*	*41.80%*				
Ethnicity	800	3912				
White	*75.40%*	*77.70%*				
Black	*3.80%*	*2.10%*	13.356	4	0.010	0.053
Hispanic	*18.00%*	*16.50%*				
Asian	*1.40%*	*2.60%*				
American Indian	*1.50%*	*1.20%*				
Disability	335	3238				
Yes	*3.00%*	*3.70%*				
No	*97.00%*	*96.30%*				
Veteran	402	3401				
Yes	*19.90%*	*6.90%*	79.272	1	0.000	0.144
No	*80.10%*	*93.10%*				
Pell grant eligibility	847	4409				
Yes	*24.60%*	*36.40%*	43.808	1	0.000	-0.091
No	*75.40%*	*63.60%*				
Employment	847	4409				
Yes	*38.50%*	*55.30%*	80.277	1	0.000	-0.124
No	*61.50%*	*44.70%*				
Time status	684	3317				
Full-time student	*37.00%*	*48.40%*	29.622	1	0.000	-0.086
Part-time student	*63.00%*	*51.60%*				
Age	846	4019				
Mean	*32.29*	*26.89*	-11.648	1141.81	0.000	0.50
Standard Deviation	*12.01*	*10.66*				

*Test statistics appear in the table only for variables found to have a statistically significant association with cohort membership.

[44] The value shown in the test statistics column is the chi-square value for categorical variables and the t-value for continuous variables.

Comparative Analysis: Student Outcomes

Next we turn out attention to the specific outcome variables of interest to see if there were any differences between the cohorts. Again we will present our findings as either percentages (for categorical variables) or as means and standard deviations (for continuous variables) and test whether any differences that emerge are statistically significant and to what appreciable effect.

Program Completion and Credentialing Outcomes

As shown on Table 16, there was a far greater proportion of program completers among state-redesign students than among the historic cohort—nearly 40 percent of students in the state-redesign cohort completed their program versus less than 7 percent of students in the historic cohort. This association is statistically significant with a moderate effect size (0.37). As a result of this imbalance, even though there are more participants in the historic cohort than in the state-redesign cohort, there are more completers in the state-redesign cohort, even in terms of raw numbers. Note, a number of different factors, e.g. ,career coach, type of redesign, halo effect, and possibly their dynamic interaction, may have contributed to the better outcomes for those in the state redesign cohort. However, we cannot make a direct correlation that any one of these factors, including the redesigns, had a direct impact on the outcome.

When we break down the groups of program completers according to the type(s) of credential they earned, however, the distribution is different. Both AAS-only completers and certificate-only completers accounted for slightly *higher* proportions of completers in the historic cohort than they did among the cohort of state-redesign completers. It is possible, then, that much of the observed difference in program-completion rates between the cohorts can be attributed to AAS-and-certificate completers, the majority of whom were members of the state-redesign cohort.[45] The nuance this adds to our original finding regarding program completers is likely of more value than the across-group comparisons of completer types themselves, since we're talking about very small differences here; as was the case with most of the demographic variables discussed above, this association between cohort membership and type of completer was statistically significant but had a small effect size (0.13).

We also looked at program completion in terms of the number of credentials (certificates and/or degrees) students earned in each cohort. As shown in Table 16, state-redesign students on average earned more credentials than students in the historic cohort earned: for each credential earned by students in the historic cohort, two credentials were earned by students in the state-

[45] We should note that we calculated the percentages for types of completer based on the total number of completers. Thus, we should look at the percentages within the group. As an example, completers in the historic cohort are less likely to be AAS-and-certificate completers, and the majority of them are certificate-only completers. In contrast, while the majority of state-redesign completers are also certificate-only completers, they are more likely to be AAS-and-certificate completers than are their historic-cohort counterparts.

redesign cohort. Again we find this difference to be statistically significant, though with a small effect size (0.18).

The final two indicators related to program completion measure the number of energy credits as well as the total number of credits earned by students in each cohort. We arrived at these figures by calculating the number of credits associated with the courses relevant to each variable in which students received grades of C or better. The mean of each variable, then, represents the average number of credits earned by students in the cohort. Table 16 shows that, with regard to energy credits, students in the state-redesign cohort earned, on average, more credits than did students in the historic cohort—the average number of energy credits earned by state-redesign students was 15.5, while the average number of energy credits earned by members of the historic cohort was around 9.5. This difference is statistically significant, with a moderate-to-large effect size (0.71). In contrast, when we consider the total number of credits earned by students in each cohort—including those earned in both energy and non-energy courses—students in the historic cohort earned more credits on average: they earned an average of 46 credits overall, whereas students in the state-redesign cohort earned only 30 credits on average. This difference, too, is statistically significant, with a moderate effect size (-0.56).

When we combine the results of our analysis of both credit-based variables, then, we see that students in the historic cohort took fewer energy courses but took more non-energy courses—and, presumably, spent more time in school—overall. These findings imply that the state redesigns of Colorado's energy programs may have shortened students' time to credential while at the same time increasing the amount of energy-industry-related training they received. It is important to remember, however, that it is possible that these relationships arose from variables that were not considered in the analysis rather than from the state redesigns themselves. For example, the presence of career coaches - intentional advising and follow up - may have helped energy students to deal with and/or resolve some of the challenges that historically interfered with students' ability to remain in a program and/or progress from one semester to another.

Table 16. DESCRIPTIVE ANALYSIS OF PROGRAM COMPLETION OUTCOMES FOR STATE-REDESIGN AND HISTORIC COHORT SAMPLES

Outcome variables	State Redesign	Historic	Test statistics value	Degree of freedom	Probability value	Effect size
Program Participant	847	4409				
Program Completer	847	4409				
Yes	*39.40%*	*6.60%*	733.079	1	0.000	0.373
No	*60.60%*	*93.40%*				
Type of completer	334	290				
AAS-only completer	*13.80%*	*20.00%*				
Certificate-only completer	*68.30%*	*69.70%*	9.903	2	0.008	0.126
AAS-and-certificate completer	*18.00%*	*10.30%*				
Number of credentials earned	334	266				
Mean	*1.60*	*1.43*	-2.272	576.798	0.023	0.176
Standard Deviation	*1.12*	*0.73*				
Energy credit earned	776	3870				
Mean	*15.51*	*9.41*	-15.349	978.193	0.000	0.705
Standard Deviation	*10.43*	*8.25*				
Total credit earned	847	4409				
Mean	*30.13*	*46.26*	18.050	1491.323	0.000	-0.558
Standard Deviation	*22.45*	*29.98*				

Employment, Continuing Education, and Academic Outcomes

Next we will examine how the cohorts differ in terms of our remaining outcome variables, which relate to employment, continuing education, and academic performance. The results of this analysis are shown in Table 17. We measure employment outcomes in several different ways. First, we consider each student's wages pre- and post-completion and examine the difference between those figures. After receiving their credentials, students in the historic cohort out-earned students in the state-redesign cohort by about $159.04, but that difference was not found to be statistically significant.

Comparing pre- and post-completion wages is important because any difference in these values is considered an approximation of the labor-market return on education. Positive values indicate a positive return on students' investment in education—that is, positive values indicate that students' wages improved after they completed their programs. Furthermore, the higher the value, the greater is the return. As a rough estimation, then, state-redesign students received, on average, a return of about $4,286 for the efforts they put into their education, whereas members of the historic cohort received a return of around $4,445 for those same efforts. While the difference between these dollar values may seem substantial, it is important to remember that, as mentioned above, this result lacks statistical significance; in other words, it is likely to be attributed to random chance rather than to any substantive difference between the two cohorts. It is also worth noting that we are not able to say that the post-completion wage increase among students in either cohort is attributable to the earning of a credential alone, as other factors not considered in our analysis could have influenced these results. Additionally, over the period of the grant the energy industry changed drastically as prices dropped.

While the variable discussed above examined wage differences in terms of quantity (and thus was continuous), we also considered a dichotomous wage increase variable that ignored the magnitude of any difference and simply indicated whether a student's post-completion wage was higher than his or her pre-completion wage. Table 17 shows that the historic cohort had a slightly higher percentage of students with wage increases than did the state-redesign cohort. The association of wage increase and cohorts, however, is not statistically significant. This result indicates that students were equally likely to experience a post-completion wage increase *of some size* regardless of their cohort membership.

It should be noted that when searching for and calculating post-completion wages, we took into consideration the availability of wage data and its relation to the academic calendar. Due to delays inherent in wage-data availability, we had wage data available only through the first quarter of 2015 at the time of our analysis. This meant that post-completion wages were not available for a subset of students in the state-redesign cohort—those students whose completion term was spring 2015. This was not the case for the historic cohort, for whom wage data was available for all students. Therefore, to strike a balance between the two cohorts, we excluded from our analysis all post-completion wages for historic cohort students whose completion term was fall 2011.

Our analysis of post-completion employment revealed similar differences between the state-redesign and historic cohorts. Among the historic cohort, about 57 percent of students were employed after program completion, whereas among the state-redesign cohort, only 37 percent were employed after completing their programs. As was the case with our post-completion wage findings, while this association was statistically significant, there was only a small effect size (-0.20). Moreover, when we accounted for students' pre-completion employment status (incumbent vs. non-incumbent worker) when considering post-completion employment, this relationship changed considerably; among the incumbent workers (those who were employed when they began their programs), there was no longer any statistically significant difference between the post-completion employment rates of state-redesign (78 percent) and historic cohort (79 percent) students. This indicates that among those who were employed at the start of the program, the majority were still employed post-completion regardless of cohort membership. However, when looking at non-incumbent workers (students who were not employed at the start of their programs), only about 17 percent of students in the state-redesign cohort were employed after program completion compared to 41 percent of students in the historic cohort. This result is similar to the one that emerged when we compared all students regardless of pre-completion employment status; the percentage is higher for the students in historic cohort (though in this case the gap is slightly wider), the association is statistically significant, and the effect size remains small at 0.274[46].

One of the reasons for the slight advantage enjoyed by members of the historic cohort in terms of post-completion employment could be a difference in the overall economic environment during the particular years that students from each cohort received their credentials. To investigate this idea, we looked at the unemployment statistics in the state of Colorado from 2009 to 2014 for residents between the ages of 25 and 64 who had some college or who had earned an associate degree.[47] Figure 3 presents the trend in unemployment rates. When we compared each cohort's completion dates with the unemployment trend in Colorado, we could see that unemployment rates tended to be higher when members of the state-redesign cohort received their credentials than they were when members of the historic cohort did. Since state-redesign students therefore would have found themselves graduating into a less favorable situation in terms of finding employment, the subtle differences we found in the post-completion employment rates between the two cohorts are just as likely to be related to differences in the overall economic environment as they are to differences between the two programs.[48]

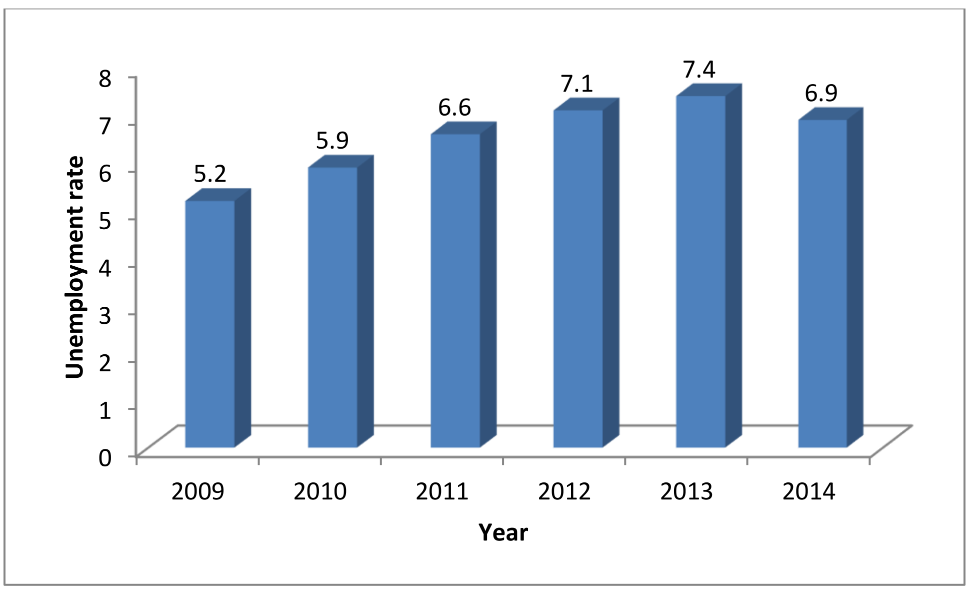

Figure 2. Colorado unemployment rates for residents ages 25–64 with some college or an associate degree

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[46] Please see Appendix F for the result of this analysis for incumbent and non-incumbent workers separately.
[47] *American Community Survey, 5-year estimates, 2010–2014.* [Data file]. Washington, DC: United States Census Bureau. Available from http://factfinder.census.gov
[48] SEE EERC's COETC Interim Energy Report for further discussion re changes in the economic context for graduates.

Neither retention in employment nor continued education was significantly associated with cohort membership. Students were considered to have retained employment if they were employed for the two consecutive quarters following the receipt of their credential. The employment-retention rate of students in the historic cohort was only slightly higher than that of students in the state-redesign cohort (77 percent compared with 74 percent). Though the difference in continued education between cohorts was slightly larger—about 42 percent of students in the historic cohort continued their education after receiving their initial credential, while nearly 36 percent of state-redesign students did so—that result, too, lacked statistical significance.

We also compared members of the two cohorts based on two different measures of academic performance. First we counted the number of A grades that students received in their redesigned (or historic equivalent) energy courses. Then we counted the number of times students received a grade of C or higher in those same courses. Our findings indicate that on average the number of A grades received in energy courses was higher among members of the state-redesign cohort than among members of the historic cohort. This difference was statistically significant ($p = 0.000$) with an effect size of 0.38, which is considered moderate. Students in the state-redesign cohort also performed better than members of the historic cohort did when it came to passing (earning a C or better in) their energy courses. Again the association was statistically significant, but this time the effect size was so tiny as to imply the relationship has no practical significance.

Table 17. DESCRIPTIVE ANALYSIS OF EMPLOYMENT, CONTINUING EDUCATION, AND ACADEMIC PERFORMANCE OUTCOMES FOR STATE-REDESIGN AND HISTORIC COHORTS

Outcome variables	State Redesign	Historic	test statistics value*	Degree of freedom	probability value	effect size
Wage pre- and post-completion	124	168				
Mean	$4,286	$4,445				
Standard Deviation	$5,645	$5,048				
Wage Increase	124	168				
Yes	82.30%	86.90%				
No	17.70%	13.10%				
Employed after program completion	334	290	25.249	1	0.000	-0.201
Yes	37.10%	57.20%				
No	62.90%	42.80%				
Retained in employment after program completion	124	166				
Yes	74.20%	77.10%				
No	25.80%	22.90%				
Education after program completion	334	290				
Yes	35.60%	40.30%				
No	64.40%	59.70%				
Grade A in energy courses	676	2572	-8.354	1055.994	0.000	0.403
Mean	3.41	2.42				
Standard Deviation	2.45	2.45				
Grade C or better in energy courses	847	4409	15.717	1115.67	0.000	0.062
Mean	4.28	2.56				
SD	3.07	2.72				

*Test statistics appear in the table only for variables found to have a statistically significant association with cohort membership.

PART THREE: MULTIVARIATE ANALYSIS

Methodology

In this section we present the results of a series of regression analyses conducted on the outcome variables discussed in the previous sections. For outcome variables that were continuous, we used a linear regression model. For binary outcome variables, we used a logistic regression model. In certain cases, our outcome variables represent count data. Count variables, also called discrete variables, are always positive integers starting from zero that represent numbers of (counted) things rather than rates. Coxe, West, and Aiken (2009) indicate that the use of a variable containing count data as an outcome variable in linear regression produces biased results, particularly if the average value of the outcome variable is below 10—as is the case, for example, with our variable that counts the number of credentials earned by each student. They argue that when an outcome variable contains count data, the preferred regression method is a Poisson model, which accounts for these biases.[49] We will therefore present Poisson regression results where appropriate.

We included school as a predictor variable in our models when sample sizes allowed us to do so. However, we found that opportunities to do so were rare, since the state-redesign sample is relatively small to begin with; once that group is broken down into categories, sample sizes diminish quickly, which can produce biased results. Similarly, we were not able to include variables on disability or veteran status in any model; since those values tended to be small, including them in the analysis produced large error terms.

Although other predictor variables were plugged into each model, when we report the results in the discussions to follow, we will include in the tables only those predictors that were shown to have a statistically significant effect on the variable of interest. Also, at this first stage of our multivariate analysis, we included all the unique cases from both the state-redesign and historic cohorts without any matching. In a subsequent section, we will reexamine these results using propensity score matching to test these results for any possible bias.

We will begin our cohort comparisons by examining outcomes related to program completion, then discuss trends in employment and continuing education, and finally examine any differences that emerge with regard to their academic performance.

Program Completion Outcomes

We used several measures of program completion in this report; each is described in detail in the descriptive analysis above. First, we looked at overall completion rates. Second, we look at what kind of credentials were earned. Then we used two discrete measures: the count of

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[49] Coxe, S., West, S. G., and Aiken, L. S. (2009, March). The analysis of count data: a gentle introduction to Poisson regression and its alternatives. *Journal of Personality Assessment*, *91*(2), 121–136.

credentials (certificates or degrees) earned and the total number of energy credits earned. (We define a credit as a course in which a student received a grade C or better.)

Predictors of Program Completion

Our regression results indicate that, among the variables entered into our model, membership in the state-redesigned cohort had the greatest positive effect on program-completion rates (Table 18). The odds of a state-redesign student completing his or her program were nine times higher than the odds of a historic-cohort student doing so. Keep in mind, however, that this model does not permit us to state definitively that the improved completion rate was a *direct result* of cohort membership. At this point we are not clear as to the causal effect of the state redesign. What we can say generally is that students in state-redesigned programs tended to have a higher probability of completing their program than did students in the historic cohort. Student's academic performance is another factor that contributed to program completion. Generally, students who received excellent grades in redesigned courses were more likely to complete their programs. The better students performed in their redesigned courses (measured as the more A grades received in energy courses), the higher were their odds of receiving a credential. On the other hand, when students were required to take developmental education (DE) courses, their odds of completing their program were reduced. The more DE credits a student had to earn, the less likely he or she was to reach program completion. The literature on the effects of DE courses on graduation rates is mixed, with some authors attributing a negative effect to DE coursework and others indicating no effects or positive effects. Attewell, Lavin, Domina, and Levey, for example, found that DE coursework had no significant effect on program completion with regard to students attending two-year colleges but that it had a significant negative effect on students attending four-year colleges.[50] However, as mentioned previously, these results may be obscured, as they emerged prior to matching the state-redesign and historic cohorts.

We also found that attending different schools had significantly different ($p = 0.000$) effects on program-completion rates. When entering individual schools into the regression model, we used TSJC as the reference school because, as was shown in Table 3, TSJC had the highest ratio of program completers to program participants. (78 percent of all TSJC program participants completed their programs.) We can see that enrollment in any of the five schools entered into the model was negatively associated with program completion as compared to enrollment at TSJC. However, looking at the odds ratios among only those five schools, students attending RRCC had the highest odds of completing their programs.

[50] Attewell, P., Lavin, D., Domina, T., and Levey, T. (2006). New evidence on college remediation. *The Journal of Higher Education*, *77*(5), 886–924.

Table 18. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING PROGRAM COMPLETION

Parameters	Beta	Standard error	Degree of freedom	Sig.	Exp(Beta)	95% C.I.for EXP(B) Lower	Upper
State redesign	2.229	0.266	1	0.000	9.292	5.514	15.659
Credits earned in DE courses	-0.051	0.026	1	0.048	0.950	0.903	0.999
Grade A in energy courses	0.635	0.043	1	0.000	1.886	1.734	2.052
SCHOOL_FINAL			5	0.000			
Aims	-2.564	0.373	1	0.000	0.077	0.037	0.160
CMC	-2.413	0.449	1	0.000	0.090	0.037	0.216
FRCC	-2.096	0.500	1	0.000	0.123	0.046	0.327
NJC	-3.253	0.683	1	0.000	0.039	0.010	0.147
RRCC	-1.381	0.349	1	0.000	0.251	0.127	0.498
Full-time student	-0.503	0.233	1	0.031	0.605	0.383	0.955
Constant	-2.355	0.512	1	0.000	0.095		

Across all schools, full-time students had lower odds of completing their programs than did part-time students; as we will see in the next section, however, this effect did not hold across all categories of credential type.

Types of Energy Credentials Earned

As shown on Table 19, across the types of awards, state-redesign students had higher odds of completion than students in the historic cohort. Since students with excellent grades tended to have higher odds of completion, it should not be surprising to discover that students in the state-redesign cohort also performed better in their energy courses regardless of which credential was being pursued.

In the previous section, we found that full-time students were less likely to complete their programs than part-time students were. But once students in each enrollment category were further broken down into groups according to which credential(s) they earned, full-time students had lower odds of completion only among certificate-only completers; that relationship disappeared among students who earned AAS degrees. These results imply that full-time students are more likely to focus their energies on degree programs rather than on earning certificates.

Pell-eligible students were more likely to earn either an AAS degree or an AAS with certificate than were students who were not eligible for the grant, but Pell status did not seem to affect the rate of completion for certificate-only completers. Age was positively related only to AAS-and-certificate earners. Finally, black students had higher odds of completing both an AAS and at least one certificate together. We did not examine the completion rates of different completer types by school because doing so would have reduced the sample size to the point where any reliable analysis would have been impossible.

Table 19. SUMMARY OF REGRESSION ANALYSES FOR VARIABLES PREDICTING TYPE OF ENERGY CREDENTIALS EARNED BY PROGRAM COMPLETERS

	AAS-only completer		Certificate-only completer		AAS-and-certificate completer	
Parameters	**Beta**	**Sig.**	**Beta**	**Sig.**	**Beta**	**Sig**
State redesign	4.189	0.000	3.435	0.000	3.901	0.000
Grade A in energy courses	0.398	0.000	0.523	0.000	0.419	0.000
Pell grant eligibility	1.356	0.016			1.755	0.010
Age at first redesign					0.061	0.042
Full-time student			-0.916	0.026		
Employed						
Black					1.556	0.005
Constant	-8.758	0.000	-5.340	0.000	-10.314	0.000

Credential Stacking

As Table 20 indicates, the results are slightly different when we use a discrete measure for program completion—namely, the number of credentials earned by each program completer. When it comes to stacking credentials, we again observed the positive effect of both state-redesign-cohort membership and strong academic performance, and again, older students and those who were eligible to receive Pell grants had a higher likelihood of earning more awards. Interestingly, earning more credits in DE courses was also positively related to the likelihood of earning more credentials; this finding is surprising given that the association was reversed when we looked at the relationship between DE credits and the likelihood of completing a program. One possible implication here is that the same persistent nature that drives certain students through their DE coursework and into their career and/or academic programs may also drive them to continue pursuing their education beyond the first credential earned.

Table 20. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING THE NUMBER OF ENERGY CREDENTIALS EARNED PER PROGRAM COMPLETER

Parameters	Beta	Std. Error	Degree of freedom	Sig.	Exp(Beta)	95% Wald Confidence Interval for Exp(B)	
						Lower	Upper
State redesign	0.286	0.129	1	0.027	1.332	1.033	1.716
Pell grant eligibility	0.218	0.097	1	0.024	1.244	1.029	1.503
Credits earned in DE courses	0.030	0.014	1	0.030	1.030	1.003	1.058
Age at first redesign	0.015	0.004	1	0.000	1.016	1.008	1.023
Grade A in energy courses	0.045	0.014	1	0.001	1.046	1.018	1.076
Intercept	-0.614	0.244	1	0.012	0.541	0.335	0.873

Number of Credits Earned in Energy Courses

Our measure of the credits earned in energy courses represents the sum of credits earned by a student across the energy courses taken. This measure of accumulated credits was established in existing literature as an indicator of program completion.[51] Similar to the results above, membership in the state-redesign cohort and students' academic performance had the greatest effects on the accumulation of energy credits. As shown in Table 21, membership in the state-redesign cohort increases energy-credit earning by 2.8 credit hours, and the better the student's performance, the higher the number of energy credits earned. Pell-eligible students tended to earn more energy credits than those who did not receive the grant. At the same time, more energy credits were earned by males and incumbent workers than by females and those not employed. Finally, age tended to have a negative relationship with earning energy credits; the older the student, the fewer energy credits he or she was likely to have earned.

[51] Attewell et al (2006). op. cit.

Table 21. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING THE NUMBER OF CREDITS EARNED IN ENERGY COURSES

Parameters	Beta	Std. Error	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound	Collinearity Statistics Tolerance	VIF
State redesign	2.812	0.205	0.000	2.410	3.214	0.779	1.284
Credits earned in DE courses	0.037	0.013	0.003	0.012	0.062	0.822	1.217
Pell grant eligibility	0.884	0.154	0.000	0.583	1.186	0.855	1.169
Grade A in energy courses	2.903	0.038	0.000	2.829	2.977	0.813	1.230
Age at first redesign	-0.042	0.006	0.000	-0.054	-0.030	0.816	1.226
Employment	0.386	0.143	0.007	0.105	0.667	0.956	1.046
Male	0.720	0.148	0.000	0.430	1.009	0.908	1.102
Constant	3.523	0.221	0.000	3.090	3.957		

Post-Completion Employment and Continuing Education Outcomes

We will now report the result of the multivariate analysis for employment and continuing education. First, we examined wage increases as a binary outcome variable that reported whether a student experienced any increase in wage post-completion. Second, we examined post-completion employment rates. We should note that the sample sizes for these outcome indicators are generally small, since we limited these analyses to program completers only. Because of this, the results in Table 22 and the discussion in the following sections should be viewed with caution.

Post-employment Wage Increases

Consistent with what we learned in the descriptive analysis above, cohort was not associated with post-completion wage increases. In the descriptive analysis we looked at both whether a wage increase occurred as well as at the dollar amount of any change in wage (positive or negative) that occurred between the pre- and post-completion readings; in both cases, we did not find any differences between the two groups that had any practical significance. Similar findings were observed in the regression analysis. In fact, none of the predictors we considered in our regression analysis produced any statistically significant effects on post-completion wage increases.

Post-Completion Employment

Here also we did not find any statistically significant effect with regard to cohort membership. The analysis of post-completion of employment shown in Table 22 revealed statistically significant effects related to Pell status, age, incumbent worker status, and gender. Particularly, those who were eligible to receive Pell grants had higher odds of finding employment post-completion than did those who were ineligible. Incumbent worker status had the greatest effect on post-completion employment rates; most incumbent workers remained employed post-completion. Every unit increase in age was negatively related to employment post-completion—in other words, the older the student, the less likely he or she was to be employed within 2 quarters of receiving a credential—and males had lower odds of post-completion employment than females did. The effects of gender, age, and Pell status being observed here could be due to interactions between those variables. For example, gender and Pell status seem to be negatively related to each other: When we reran this analysis and included the interaction term for Pell status and gender in the model, the significant effects of Pell status, gender, and age disappeared.[52]

Table 22. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING POST-COMPLETION EMPLOYMENT

Parameters	Beta	Standard error	Degree of freedom	Sig.	Exp(B)	95% Confidence Interval for EXP(B) Lower	Upper
Pell grant eligibility	0.675	0.326	1	0.038	1.963	1.036	3.720
Age at first redesign	-0.029	0.014	1	0.032	0.971	0.945	0.997
Employed	2.551	0.309	1	0.000	12.814	6.987	23.501
Male	-0.779	0.350	1	0.026	0.459	0.231	0.912
Constant	0.795	1.025	1	0.438	2.215		

Continuing Education

Given our finding in the descriptive analysis that students in the state-redesign cohort were more likely to stack credentials than were students in the historic cohort, we expected our regression analysis to show that membership in the state-redesign cohort was positively related to education after program completion. Surprisingly, cohort did not emerge as a significant predictor of post-completion education. Instead, we found that the only predictors that had a positive effect on continuing education were receiving credit in DE courses, performing better (receiving A grades) in redesigned (or historic equivalent) energy courses, and being an incumbent worker (see Table 23 below).

We also included type of completer (AAS-only, certificate-only, and AAS & certificate) in our model to look for any effect that earning each form of credential might have on a student's decision to continue his or her education. We used those who earned both an AAS and at least one certificate as a reference category. We can see that earning an AAS only was negatively related to continuing education, which could indicate that those receiving their AAS degree

[52] A complete discussion of the analysis we refer to here is not included in this report.

either no longer felt it was necessary to continue their education or, if they did continue their education, they transferred to a four-year college to do so.

Table 23. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING CONTINUING EDUCATION

Parameters	Beta	Standard error	Degree of freedom	Sig.	Exp(Beta)	95% C.I. for EXP(B)	
						Lower	Upper
Credits earned in DE courses	0.147	0.044	1	0.001	1.158	1.062	1.264
Grade A in energy courses	0.195	0.050	1	0.000	1.215	1.102	1.340
Employed	0.694	0.279	1	0.013	2.001	1.158	3.458
Type of completer*			2	0.001			
AAS-only completer	-2.406	0.652	1	0.000	0.09	0.025	0.324
Constant	-2.106	0.944	1	0.026	0.122		

*The reference category for Type of Completer in this model was AAS-and-certificate completer

Academic Performance Outcomes

To examine our predictor variables' effects on academic performance in energy courses, we first looked at the number of times each student received a C or better across all energy courses. We then looked at the number of times the student received an A in a redesigned (or historic equivalent) energy course. Because both of these measures are count data, we will report the Poisson regression model results.

Earning Grade C or Better in Energy Courses

The expected log count of those receiving grade C or better was positively associated with membership in the state-redesign cohort, indicating that those students performed better than students in the historic cohort did. However, this change was not large enough to have any practical significance. Further, the effects of other predictors in this model were even smaller re impact on earning a C. Nevertheless, as seen in Table 24 below, students eligible for Pell grants tended to perform better in their energy classes than did those who were not eligible to receive those funds, males received grades of C or higher more often than females did, and full-time students performed better than part-time students. With regard to ethnicity, Hispanic students had a lower performance in energy courses than did members of other ethnic groups in the study. Finally, we observed that increases in age are positively related to increases in the expected number of C or better grades received.

Table 24. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING EARNING GRADE C OR BETTER ACROSS ENERGY COURSES

Parameters	Beta	Std. Error	Degree of freedom	Sig.	Exp(Beta)	95% Wald Confidence Interval for Exp(B) Lower	Upper
State redesign	0.533	0.026	1	0.000	1.705	1.620	1.793
Pell grant eligibility	0.048	0.023	1	0.034	1.049	1.004	1.097
Male	0.089	0.023	1	0.000	1.093	1.045	1.142
Full-time student	0.147	0.021	1	0.000	1.158	1.111	1.207
Hispanic	-0.071	0.029	1	0.014	0.931	0.879	0.986
Age at first redesign	0.014	0.001	1	0.000	1.014	1.012	1.016
Intercept	0.347	0.035	1	0.000	1.415	1.320	1.516

High Achievement in Energy Courses

Our next model, presented in Table 25, examines high achievement—the likelihood of receiving A grades—in energy courses. Students in the state-redesign cohort performed better than students in the historic cohort. Being male, a full-time student, and older were also positively related to high achievement in energy courses. On the other hand, students who were employed, black, Hispanic, or had earned credits in DE courses were less likely to receive A grades than their counterparts. Of interest is the negative relationship of credits earned in DE courses. Our measure suggests that the more credits a student earned in DE courses, the fewer A grades he or she was likely to have received in energy courses.

Table 25. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING HIGH ACHIEVEMENT ACROSS ENERGY COURSES

Parameters	Beta	Std. Error	Degree of freedom	Sig.	Exp(Beta)	95% Wald Confidence Interval for Exp(B) Lower	Upper
State redesign	0.569	0.033	1	0.000	1.766	1.655	1.885
Male	0.074	0.030	1	0.015	1.076	1.014	1.142
Full-time student	0.245	0.028	1	0.000	1.278	1.208	1.351
Employed	-0.045	0.029	1	0.110	0.956	0.904	1.010
Black	-0.209	0.089	1	0.018	0.811	0.682	0.965
Hispanic	-0.240	0.043	1	0.000	0.787	0.723	0.855
Credits earned in DE courses	-0.020	0.003	1	0.000	0.980	0.974	0.985
Age at first redesign	0.028	0.001	1	0.000	1.029	1.027	1.031
Intercept	-0.586	0.049	1	0.000	0.556	0.506	0.612

Propensity Score Matching Analysis

The results we have presented up to this point have provided a descriptive analysis of the ways in which the state-redesign and historic cohorts differed with regard to a set of demographic characteristics. However, because we could not randomize the allocation of students to each cohort, we cannot be sure how reliable our results are. For example, to understand that the differences we observed in the rates of program completion between the two groups is the direct result of cohort membership, we need to know that the students who comprise each cohort are similar in both observed and unobserved characteristics. If being female is a factor in program completion, for example, and there was a greater proportion of females in the state-redesign cohort than there was in the historic cohort, that difference in the gender makeup of the cohorts would have biased the result of our analysis of program completion. In other words, even though program completion rates appear to be better for members of the state-redesign cohort, that advantage might be attributable to the gender makeup of that cohort rather than to any difference in the quality of the state-redesigned programs. Moreover, students in the two cohorts may differ on other characteristics we were not able to account for that could further obscure the effect of cohort membership.

Propensity score matching is a statistical technique that helps to account for these limitations. Students in the historic cohort are matched to those in the state-redesign cohort based on a probability score that accounts for all observed characteristics. Thus, the probability scores in our propensity score analysis accounts for such characteristics as gender, age, ethnicity, Pell grant eligibility, incumbent worker status, and total credit hours, all of which had a statistically significant relationship with cohort membership. Below we provide the pre- and post-matching results on these characteristics.

The distributions of students' characteristics by cohort are different pre-match than they are post-match. As the descriptive analysis illustrated in Table 15 indicated, students differed significantly in all the characteristics presented in Table 26 at the pre-match period. For example, there were more males and more Pell-eligible students in the state-redesign than historic cohort, and students in the state-redesign cohorts tended to be younger than students in the historic cohort. After propensity score matching, however, the resulting sample of students showed no statistically significant difference with regard to gender or age. In fact, the post-match cohorts are more similar in most of the characteristics we examined; the one minor exception is Pell eligibility, where the association remains statistically significant but with a small effect size.

Table 26. SUMMARY OF DEMOGRAPHIC CHARACTERISTICS OF PRE-MATCH AND POST-MATCH COHORTS

	Before match		After match	
Variable	**State Redesign**	**Historic**	**State Redesign**	**Historic**
Program Participant	847	4409	335	335
Gender	845	4398	335	335
Male	82.10%	58.20%	76.70%	73.70%
Female	17.90%	41.80%	23.30%	26.30%
Ethnicity	800	3912	335	335
White	75.40%	77.70%	77.00%	82.40%
Black	3.80%	2.10%	3.00%	2.70%
Hispanic	18.00%	16.50%	16.70%	12.50%
Asian	1.40%	2.60%	1.50%	1.50%
American Indian	1.50%	1.20%	1.80%	0.90%
Disability	335	3238	212	206
Yes	3.00%	3.70%	2.80%	5.30%
No	97.00%	96.30%	97.20%	94.70%
Veteran	402	3401	221	211
Yes	19.90%	6.90%	6.80%	10.40%
No	80.10%	93.10%	93.20%	89.60%
Pell grant eligibility	847	4409	335	335
Yes	24.60%	36.40%	14.60%	27.20%
No	75.40%	63.60%	85.40%	72.80%
Employment	847	4409	335	335
Yes	38.50%	55.30%	46.00%	48.10%
No	61.50%	44.70%	54.00%	51.90%
Time status	684	3317	288	197
Full-time student	37.00%	48.40%	46.20%	46.70%
Part-time student	63.00%	51.60%	53.80%	53.30%
Age	846	4019	335	335
Mean	32.29	26.89	29.72	30.5
Standard Deviation	12.01	10.66	10.81	13.11
Total hours	847	4409	335	335
Mean	33.61	53.72	42.46	42.49
Standard Deviation	23.63	31.14	27.29	28.53

Post-Match Outcomes: Program Completion

As shown in Table 27, membership in the state-redesign cohort remains a statistically significant predictor of in our post-match analysis of program completion. However, the effect size is smaller than before: the odds of completion were about 9 times higher for state-redesign students than they were for historic-cohort students in the pre-match analysis, but their odds of program completion are only about three times higher in the post-match analysis. High achievement—measured in terms of the number of A grades that a student received in energy courses—also retains its statistically significant positive effect post-match. Similarly, the number of credits that a student had to earn in DE courses retains its negative effect on program completion. Finally, the effect of attending each energy college is similar to the pre-match analysis results. When compared to TSJC, which is the reference category, attendance at any other energy school continues to show a negative effect on program completion in the post-match analysis.

Several new associations emerged post-match that did not appear statistically significant in the pre-match analysis. Age, for example, now shows a negative effect on program completion that is statistically significant, whereas being Hispanic now shows a significant positive effect on program completion.

Table 27. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING PROGRAM COMPLETION USING POST-MATCH COHORT DATA

Parameters	Beta	Standard error	Degree of freedom	Sig.	Exp(Beta)	95% C.I.for EXP(B)	
						Lower	Upper
State redesign	0.916	0.394	1	0.020	2.498	1.154	5.409
Grade A in energy courses	0.503	0.061	1	0.000	1.654	1.467	1.866
Credits earned in DE courses	-0.117	0.041	1	0.005	0.890	0.820	0.965
Age at first redesign	-0.033	0.015	1	0.027	0.968	0.940	0.996
Hispanic	1.160	0.456	1	0.011	3.190	1.304	7.801
SCHOOL_FINAL			5	0.000			
Aims	-2.908	0.628	1	0.000	0.055	0.016	0.187
CMC	-2.329	0.746	1	0.002	0.097	0.023	0.420
FRCC	-1.683	0.841	1	0.045	0.186	0.036	0.966
NJC	-5.796	1.937	1	0.003	0.003	0.000	0.135
RRCC	-1.381	0.684	1	0.043	0.251	0.066	0.960
Constant	0.414	0.937	1	0.659	1.512		

Type of Credentials Earned

Looking at the type(s) of credential(s) earned by each program completer in the study, we find that our post-match results differ slightly from our pre-match results. Post-match results for all three completer types are shown in Table 28. It should be noted that the results here should be viewed with caution, since the sample sizes within categories of completer types were often very small.

The post-match results are generally the same for both AAS-only and AAS-and-certificate completers. Again we find that membership in the state-redesign cohort, high achievement, and

Pell-grant eligibility are positively associated with AAS-only completion. Among AAS-and-certificate completers, however, the pre-match analysis showed a statistically significant positive association between program completion and being both older and black. After the cohorts were demographically aligned, those advantages disappeared.

Among certificate-only completers, we see that both membership in the state-redesign cohort and high achievement in energy courses retain their positive associations with program completion in the post-match analysis. However, both the number of credits earned in DE courses and being Hispanic, which had no statistically associations with certificate completion in the pre-match analysis, shows significant associations post-match. We can now see that earning DE credits had a negative effect on certificate completion, whereas being Hispanic had a positive effect. Conversely, the negative effect of being an incumbent worker that was revealed in the pre-match analysis is no longer present in the post-match results.

Table 28. SUMMARY OF REGRESSION ANALYSES FOR VARIABLES PREDICTING TYPE OF ENERGY CREDENTIALS EARNED BY PROGRAM COMPLETERS USING POST-MATCH COHORT DATA

	AAS completer		Certificate completer		AAS-and-certificate completer	
Parameters	**Beta**	**Sig.**	**Beta**	**Sig.**	**Beta**	**Sig**
State redesign	2.685	0.000	1.778	0.000	1.875	0.013
Grade A in energy courses	0.383	0.000	0.328	0.000	0.356	0.000
Credits earned in DE courses			-0.138	0.001		
Pell grant eligibility	1.000	0.037			1.43	0.013
Hispanic			1.113	0.019		
Constant	-6.688	0.000	-2.488	0.000	-7.827	0.000

Credential Stacking

Our post-match results for the number of credentials earned were completely different from our pre-match results. Before matching, we found that state-redesign-cohort membership, Pell eligibility, high achievement in energy courses, age, and DE course credits all bore statistically significant associations with the number of credentials a student earned. Of these five predictors, however, only Pell eligibility[53] retains any significant association with credential earning in the post-match analysis. Thus, the four other relationships revealed in the earlier analysis were likely a result of bias in the cohort selection. The finding that income status matters re the stacking of credentials is not too surprising. One can hypothesize contributing factors, e.g. financial aid programs are time limited, grants usually require a minimum number of credits, lower income students need to find jobs more quickly, and may delay further study;

[53] The estimated log of the number of credentials earned was 1.5 times higher when considering students who were Pell eligible. Because the results were significant for only one predictor, we do not include a table here.

however, only further research including interviews will be able to identify the reasons and emergent patterns.

Number of Credits Earned in Energy Courses

Our post-match analysis indicates that membership in the state-redesign cohort, Pell eligibility, and high achievement in energy courses was positively related to the number of energy credits students earned. These results, shown on Table 29, are consistent with those we found before the cohorts were matched. We also found that age was negatively related to the number of energy credits earned, which again was consistent with our pre-match results. In contrast to the results we found before the cohorts were matched, we no longer find statistically significant associations between energy-credit earning and employment, DE coursework, or gender.

Table 29. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING THE NUMBER OF CREDITS EARNED IN ENERGY COURSES USING POST-MATCH COHORT DATA

				95.0% Confidence Interval for B		Collinearity Statistics	
Parameters	Beta	Std. Error	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
State redesign	2.198	0.540	0.000	1.137	3.259	0.849	1.178
Pell grant eligibility	2.600	0.610	0.000	1.400	3.799	0.841	1.188
Grade A in energy courses	3.097	0.097	0.000	2.905	3.288	0.832	1.201
Age at first redesign	-0.060	0.023	0.008	-0.104	-0.016	0.872	1.146
Constant	2.534	1.024	0.014	0.522	4.547		

Post-Match Outcomes: Post-completion Employment and Continuing Education

For both employment and education after program completion, the post-match analysis showed only one predictor to be statistically significant. For post-completion employment, we found that incumbent workers status[54] retained its positive effect after the cohorts were matched, whereas the pre-match associations with Pell eligibility, age, and gender were no longer statistically significant. For continuing education (course enrollment after completion of a credential), we found that only gender had a statistically significant effect. The odds of a male continuing education after receiving a credential were 0.233 times lower compared to the odds of a female doing so. This is interesting because gender was not among the four variables (DE coursework, high achievement, incumbent worker status, and AAS-only completers) that showed significant associations with continuing education in the pre-match analysis. The

[54] The odds of being employed after completion were 7 times higher for those who were incumbent workers than for those who were not incumbent workers. The coefficient for the intercept was -0.041.

results of these analyses are not presented in tables because in both cases only one predictor was statistically significant.

Post-Match Outcomes: Academic Performance

Just as we did prior to matching the cohorts according to demographic characteristics, here we examine two measures of academic performance for state-redesign and historic cohort students while controlling for other variables.

Earning Grade C or Better in Energy Courses

In the post-match analysis of academic performance shown in Table 30, we find that state-redesign students, older students, and those who attended school full time were more likely to pass their energy courses. There are some differences to report, however. The negative association we see here with regard to DE coursework was not revealed prior to matching the cohorts, while pre-match associations with Pell eligibility, gender, and ethnicity no longer show any statistically significant effects in the post-match analysis.

Table 30. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING EARNING GRADE C OR BETTER ACROSS ENERGY COURSES USING POST-MATCH COHORT DATA

Parameters	Beta	Std. Error	Degree of freedom	Sig.	Exp(Beta)	95% Wald Confidence Interval for Exp(B)	
						Lower	Upper
State redesign	0.514	0.054	1	0.000	1.671	1.503	1.858
Full-time student	0.352	0.049	1	0.000	1.422	1.292	1.565
Credits earned in DE courses	-0.020	0.005	1	0.000	0.981	0.971	0.991
Age at first redesign	0.015	0.002	1	0.000	1.015	1.011	1.019
Intercept	0.359	0.105	1	0.001	1.432	1.166	1.759

High Achievement in Energy Courses

Consistent with the results we found before matching, our post-match analysis results, shown on Table 31, indicate that more A grades were earned in energy courses by state-redesign students and those who attended school full time, and the likelihood of receiving A grades increased with age. The odds of high achievement decreased, however, as the number of credits earned in DE courses increased; this result was also consistent with our findings from before matching was applied. Our pre- and post-match results differ, however, in that we no longer find that ethnicity, gender, and employment have any statistically significant effects on students' likelihood of earning A grades in energy courses.

Table 31. SUMMARY OF REGRESSION ANALYSIS FOR VARIABLES PREDICTING HIGH ACHIEVEMENT ACROSS ENERGY COURSES USING POST-MATCH COHORT DATA

Parameters	Beta	Std. Error	Degree of freedom	Sig.	Exp(Beta)	95% Wald Confidence Interval for Exp(B)	
						Lower	Upper
State redesign	0.470	0.066	1	0.000	1.600	1.405	1.823
Full-time student	0.411	0.062	1	0.000	1.508	1.336	1.701
Credits earned in DE courses	-0.038	0.007	1	0.000	0.963	0.949	0.976
Age at first redesign	0.025	0.003	1	0.000	1.025	1.020	1.030
Intercept	-0.282	0.132	1	0.032	0.755	0.583	0.976

CONCLUSION

Promising practices were discussed above. In this section EERC focuses on leveraging resources and new sources of funding as well as sustainability.

Leveraged Resources and New Sources of Funding

An important part of the TAACCCT project has been expanding the energy programs' capacities to train students including increasing students' access to state-of-the-art equipment. To that end, colleges used TAACCCT funds to purchase equipment and/or construct new lab and classroom spaces. FRCC's investment in new equipment for both its Larimer campus solar lab and the University of Colorado's steam plant were mentioned above. Aims also purchased new equipment for its training labs. In addition, as a result of increased communication between the colleges and regional employers under TAACCCT, several colleges received equipment donations. In their final reports to EERC, two energy colleges specifically discussed the donations they had received and the effects of these contributions on their respective programs.

TSJC reported that industry partners donated consumable supplies including tin insulators, deadend insulators, crossarm braces, copper high wire, and aluminum tie wire bolts. These donations, the project lead commented, "*have helped to keep the cost of the program down*," and the college has thus not had to "*have a fee increase to cover added expenses*."

NJC also received donations from industry. For example, the college received two GE 1.5 MW gear boxes and four yaw control gear motors. The project lead stated that the scrap iron price for these materials is around $6000, and the new price for them would be $300,000. These boxes and motors are being incorporated by students into working trainers "*simulating actual tower working conditions.*" These donations to NJC, like those made to TSJC, translate into significant cost savings to the college.

NJC also reported that some of its wind program graduates now working in wind energy or a related field have been instrumental in facilitating the donation of equipment and materials to NJC. These graduates have also provided less tangible but important contributions to the program by, for example, visiting classes to talk about their experiences in the profession, suggesting ways to improve training content, and/or making employer referrals. The ongoing engagement of graduates and their employers fosters important linkages between NJC's wind energy program and the industry and speaks to the fact that the program has been successful in training the next generation—in sending graduates into the field "*with [an] appropriate work ethic and knowledge base.*" That foundation makes NJC's wind energy graduates successful in the industry and, in turn, grows the reputation of NJC.

PCC is exploring the possibility of incumbent workers using VA benefits or loans for its Commercial Driving License (CDL) courses.

Sustainability

As the COETC project neared its conclusion, many respondents expressed concerns about the sustainability of project outcomes. We identified several strategies that can be employed to ensure the continuation of the achieved results:

- The sustainability of advisory boards is in their nature—the law requires them. Continued inclusion of industry partners alongside instructors will ensure that direct communication is taking place between educators and practitioners. That, in turn, will reduce knowledge gaps between the two parties. In addition, inclusive advisory boards not only ensure that college curriculums meet employers' needs but also keep program administrators and instructors abreast of new technologies, standards developments, etc.

- Continued involvement of industry representatives as full- or part-time college instructors is a promising strategy in that it provides employers with access to potential recruits, serves as a good employment opportunity for retiring industry specialists, and benefits colleges by bringing industry expertise on board.

- Incumbent worker training is in demand by employers and is likely to be continued even without project funds. It seems that short-term, on-campus/on-site courses with flexible schedules is the best model for such trainings as they allow for better time management and better use of human resources and equipment.

- Online/hybrid instruction still faces some challenges. However, current instructors have received the training they needed and are able to use hardware and software to both update existing online/hybrid courses and develop new ones. Use of instructional designers fostered that process.

- Building new and maintaining existing mobile learning labs is a very expensive endeavor, but as one employer noted, the MLL *"is a great teaching tool and marketing tool."* Therefore, further utilization of MLLs should involve (in-kind or financial) contributions from industry partners.

- Internships are widely recognized as an important part of formal training in the energy industry. Such programs are only possible, however, when the issue of liability is resolved either through the college or employer.

- Apprenticeship models that require apprentices to go through formal trainings with the college, bring college instructors to the work site, and/or make use of MLLs are also regarded as programs that are worth supporting. These mutually beneficial models have great potential for sustainability because both sides—employer and college—have an interest in investing in and utilizing these resources when they are available to them.

APPENDIX A: List of Acronyms

AAS	Associate of applied science degree
AAC	Arapahoe Community College
Aims	Aims Community College
AWEA	American Wind Energy Association
CCA	Community College of Aurora
CC BY	Creative Commons Attribution 3.0 license
CCCS	Colorado Community College System
CCD	Community College of Denver
CDL	Commercial driver's license
CMC	Colorado Mountain College
CNCC	Colorado Northwestern Community College
COETC	Colorado Online Energy Training Consortium
CoWARN	Colorado's Water/Wastewater Agency Response Network
CSU	Colorado State University
CTA	Career and Technical Act
CTE	Career and technical education
D2L	Desire 2 Learn
EERC	Education and Employment Research Center
FRCC	Front Range Community College
HR	Human resources
LCC	Lamar Community College
MCC	Morgan Community College
MLL	Mobile learning lab
MW	Megawatts
NAICS	North American Industry Classification System
NJC	Northeastern Junior College
ODS	Operational data store

OER	Open educational resources
OJC	Otero Junior College
PCC	Pueblo Community College
PPCC	Pikes Peak Community College
PTC	Renewable Energy Production Tax Credit
RPS	Renewable power standard
RRCC	Red Rocks Community College
SMLR	The Rutgers School of Management and Labor Relations
TAA	Trade Adjustment Act
TAACCCT	Trade Adjustment Assistance Community College and Career Training
TSJC	Trinidad State Junior College
USDOL	United States Department of Labor
WFC	Workforce center
WIA	Work Investment Act
WQM	Water Quality Management

APPENDIX B: Glossary of Terms for Data Analysis

Glossary of Terms: Data Analysis	
Common Name	**Explanation**
Age	Age of student, rounded down. Age is determined using the start date of the term in which the student first took a redesigned COETC course for the Treatment Group.
Course Pass/NoPass (Multiple)	This describes whether a student passed or failed a course. Different schools had different grading systems. Generally, course grades of D or higher were assigned as passing grades. Passing grades also included S, P, and specialized grades for DE course such as U/A, U/C, etc. Withdrawals and "others" were considered nonpassing grades.
Credentials— All	Any credential earned
Credentials—Certs less than one year	Any certificate completed in less than one year
Credentials—Certs between one and two years	Any certificate earned within 12 to 24 months of enrollment
Credentials—Two-year degrees	Any two-year associate degree earned
Credits earned in DE courses	Counts the sum of credits earned by the student across all his or her developmental education courses
Eligible veterans	A student with eligible veteran status, based on the categories provided by the school.
Gender	Gender of student
Grade C or better earned in energy courses	Counts the number of times the student received grade C or higher across all energy courses in which he or she enrolled.
Grade A in energy courses	Counts the number of times the student received grade A across all energy courses (redesigned or historic equivalent) in which he or she enrolled.
Incumbent completer	An incumbent worker who is also a completer (a student who earned a COETC/Energy Program certificate or degree)
Incumbent worker	A student earning wages at the time of enrollment in his or her first redesigned (or historic equivalent) energy course
Newly credentialed employee	A student who entered employment after receiving a credential. Incumbent workers were removed from this category.
Nonpersister	A student who participated in two straight semesters who is not a COETC/Energy student
Persister	Student participated in COETC/Energy two straight semesters. These students by definition cannot be Program Completers.

Program completer	A student who earned a grant-funded credential—either an AAS or a certificate in a grant-funded program
Program participant	Unique students who enrolled in at least two redesigned energy program
Pell-grant eligible	A student who is eligible to receive a Pell grant according to federal guidelines. Data on student eligibility is provided by the school.
Person with disability	A student with a disability. Status is determined using data provided by the school.
Student credentialed and still employed	Student was newly employed after receiving a COETC/Energy credential and is still employed after three quarters
Student degree status	Degree status of student
Student ethnicity	Ethnicity of student. Not all schools report 'More than one race.' CCCS schools combine Pacific Islander with Asian.
Student pursuing further education	A student who earned a grant-funded credential and was found to be enrolled in any course (grant-funded or not) in the following semester
Total number of credit hours completed	Unique students earning at least one credit hour summed across the course and school. Shown as average credit hours completed per energy school. Total credit hour for all schools is a weighted average.
Total credit hours	Total credit hours across the individual courses that the student attempted. This includes courses for which students received a grade of A, B, C, D, F, ones which are considered in the calculation of GPA.
Students completing credit hours	Unique students earning at least one credit hour summed across the course and school
Unique students	Students enrolled during exactly one study period (historic or state redesign). Each unique student accounts for a single case of data.
Wages Earned in QX 201X (Multiple)	Wages earned in second quarter following program completion

APPENDIX C: STATE-REDESIGNED ENERGY PROGRAMS AND THEIR HISTORIC EQUIVALENTS

School	Redesigned program cohort	Pre-redesigned program cohort	Period of data coverage for comparison cohort
Aims	Oil and gas technologies AAS Oil and gas production technologies certificate Introduction to oil and gas technologies Industrial technology AAS Industrial technology level I–IV certificate	Previous AAS program Previous multi-industry systems technician	Cohorts prior to Spring 2012
CMC	Process technology AAS Industrial instrumentation control certificate Petroleum technology certificate Photovoltaic installation certificate Basic solar photovoltaic certificate	Previous process technology program Previous solar energy program	Cohorts prior to Spring 2012
FRCC	Electro-mechanical and energy tech AAS Electro-mechanical and energy tech certificate	Previous clean energy program	Cohorts prior to Fall 2012
NJC	Wind energy technician AAS Wind technician core certificate Summer intensive wind technician certificate	Previous wind energy technician program	Cohorts prior to Fall 2012
RRCC	Water quality management AAS Introduction to water treatment certificate Advanced wastewater treatment certificate Mathematics in water quality certificate Laboratory analysis certificate Distribution and collection training certificate Advanced water treatment certificate Source control and water audit certificate Intro to wastewater treatment certificate Education and experience certificate	Previous water quality management program	Cohorts prior to Spring 2012
TSJC	Southern Colorado line technician AAS Southern Colorado line technician certificate Rocky Mountain lineman technician AAS Rocky Mountain lineman technician certificate	Previous line technician program	Cohorts prior to Fall 2012

APPENDIX D: Additional Student Data—Non-Credit Students at PCC

Table D.1: Credentials earned by PCC non-credit studentsCredential	N	%
CDL Class A License	9	9%
First Responder	15	16%
Hydraulics Level I	7	7%
MSHA Refresher	4	4%
MSHA Surface	1	1%
MSHA Underground	59	62%
Total	95	99%

Table D.2: Ethnicity of PCC Non-credit Students

Ethnicity	N	%
American Indian/Native American	30	32%
Hispanic or Latino	4	4%
White	52	55%
Missing	9	9%
Total	95	100%

Table D.3: Gender of PCC Non-credit Students

Gender	N	%
Male	88	93%
Female	6	6%
Missing	1	1%
Total	95	100%

APPENDIX E: Redesigned Program Characteristics in Each Energy College

School	Total credentials offered	AAS credentials offered	Certificates offered	# of credit hours required for AAS	Average credit hours required for certificate	# online courses	# hybrid courses	# lab
Aims	9	2	7	38	11	23	3	0
CMC	5	1	4	36	17	0	24	14
FRCC	2	1	1	46	22	1	11	0
NJC	2	1	1	42	13	1	1	1
RRCC	9	1	8	34	7	15	30	6
TSJC	4	2	2	42	35	14	9	0
Total	**31**	**8**	**23**	**40**	**13**	**54**	**78**	**21**

APPENDIX F: Difference in Employment Post Completion Between State Redesign And Historic Cohort For Incumbent And Non-Incumbent Workers

Outcome variables	State Redesign	Historic	Test statistics value*	Degree of freedom	Probability value	Effect size
STUDENTS WHO WERE INCUMBENT WORKERS						
Employed after program completion	*111*	*120*	0.097	1	0.755	N/A
Yes	77.50%	79.20%				
No	22.50%	20.80%				
STUDENTS WHO WERE NON-INCUMBENT WORKERS						
Employed after program completion	*223*	*170*	29.421	1	0.000	0.274
Yes	17.00%	41.80%				
No	83.00%	58.20%				