
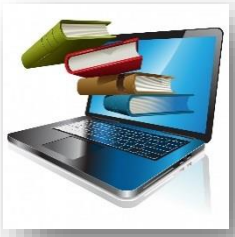

STEM-Connect at the University of Vermont, College of Engineering and Mathematical Sciences:

Program Evaluation Final Report

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The evaluation team would like to thank STEM-Connect's program management, staff, faculty, partners and participants for the time and care they took answering our questions and engaging in discussions about every aspect of the program. We would also like to thank program staff, the various University offices that were asked to supply data, and the Vermont Department of Labor's Economic & Labor Market Information Division for their work in responding to our information requests. And finally, we would like to acknowledge the contributions of Beth Cheng Tolmie, Ed.D, for her skillful and thorough interviews with program participants.

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Frequently Used Acronyms and Abbreviations

CDE	Continuing and Distance Education (UVM)
CCV	Community College of Vermont
CEMS	College of Engineering and Mathematical Sciences (UVM)
FAFSA	Federal Student Aid Application (Free Application for Federal Student Aid)
SGA	Solicitation for Grant Applications
SPSS	Statistical Package for the Social Sciences (IBM)
STEM-Connect	Science Technology Engineering and Mathematics Program at UVM
TAACCCT	Trade Adjustment Assistance Community College and Career Training
UVM	University of Vermont
Vermont HITEC	Host of the Institute for American Apprenticeships
VDOL	Vermont Department of Labor
WLO	Workplace Learning Opportunity

Executive Summary

Program Description and Activities

STEM-Connect at the University of Vermont (UVM)'s College of Engineering and Mathematical Sciences (CEMS) was designed to create certificates that provide clear and flexible pathways to employment in STEM-related fields. The program was designed to respond to the needs of both traditional and non-traditional student populations.

The program was built around stacked and latticed certificates that could be earned in two years or less. Certificate credentials included: Computer Software Certificates in Software Development, Web Development, Cybersecurity, Master's Preparation and Self Design; Computer-Aided Engineering Technology, Complex Systems (master's level), and Pre-Actuarial (Actuarial Science).

The delivery of the program consisted of regular credit-bearing academic course work, the mainstay of the university's delivery for degree programs. Delivery included on-line course work and mentoring to enable non-traditional student participants to experience and master the content. Internships were coordinated through a statewide partner that had direct access to Vermont industry (Vermont-HiTEC.) Participant support services consisted of the base support provided through the University's financial aid offices, counseling and career development. In addition, the program provided enhanced recruitment, counseling, tutoring and academic advising for participants who were non-traditional students in partnership with UVM's Division of Continuing and Distance Education (CDE).

The model that the program was built on involved the application of new and existing resources in CEMS, partnerships with Vermont business and industry, Vermont Department of Labor (VDOL) and its Career Resource Centers, and Vermont HiTEC (a non-profit apprenticeship agency). Resources were configured in the model to create capacity in CEMS to develop the program offerings and recruit participants.

Evaluation Design

The overall purpose of the STEM-Connect evaluation was to determine the extent to which UVM CEMS implemented the program plan for STEM-Connect, to determine whether the program expanded and improved CEMS's ability to deliver education and career training programs in STEM-related fields, and to determine the extent to which outcomes specified by the program were realized by the target population.

To achieve these purposes, the evaluation included both an Implementation Study and an Outcomes/Impact Study. The Implementation Study was guided by the program logic model (see Appendix 1) and included several sources of qualitative data to inform its findings. The Outcomes/Impact Study included collection of descriptive information and a comparison of STEM-Connect certificate-enrollees (referred to as participants throughout this report) with students who engaged in a TAACCCT-funded course as part of their regular university program without enrolling in STEM-Connect.

Research questions that the study was designed to answer included:

1. How was the particular curriculum selected, used, or created?
2. How were programs and program design improved or expanded using grant funds? What delivery methods were offered? What was the program administrative structure? What support services and other services were offered?
3. Did the grantees conduct an in-depth assessment of participant's abilities, skills and interests to select participants into the grant program? What assessment tools and process were used? Who conducted the assessment? How were the assessment results used? Were the assessment results useful in determining the appropriate program and course sequence for participants? Was career guidance provided and if so, through what methods?
4. What contributions did each of the partners (employers, workforce system, other training providers and educators, philanthropic organizations, and others as applicable) make to the design and delivery of the program?

Implementation Study

The Implementation Study was guided by the logic model in identifying partners, strategies, outcomes and measures and the flow of activities that provided a timeline for formative reporting and data collection. Implementation data included interviews with program leadership, staff, partners, and participants as well as meeting observations, review of program and University documents including program communications, marketing and recruitment material, course materials, certificate proposals used for university academic program approval, job maps, internal reports and quarterly and annual reports by the program to funders. For the purpose of the implementation study, capacity was defined as the "emergent combination of individual competencies, collective capabilities, assets and relationships that enables an organization or other system to accomplish a purpose and create value."[1] The measurement of capacity building included the products of the program (stackable certificates, marketing and publicity materials), the numbers of participants enrolling in the certificate programs, participant satisfaction with the program, relationships and services put into place, and the perception of key stakeholders of the extent to which capacity had been achieved and the prospects for sustainability.

Outcomes/Impact Study

The Outcomes/Impact Study was guided by an overall purpose to determine whether the program achieved its expected participant outcomes. The overall design of the outcomes/impact study was a mixed-methods, non-experimental, qualitative and quantitative approach to the research/evaluation questions. Results are reported at two levels.

Specific level 1 outcome questions were designed to answer the question stem "How many…" enrollments, completions, retentions, obtaining course credit, credentials, higher education enrollment (post completion), employment, and wages.

Specific level 2 impact questions were:

1. To what extent are the participants and non-enrolled (comparison group) different with respect to the background variables of gender, parents' level of education, age, and financial need (Bias testing question)?
2. To what extent does the STEM-Connect program result in higher wages?
3. To what extent does the STEM-Connect program result in higher rates of employment?
4. To what extent does the STEM-Connect program result in higher grade point averages?

The level 2 impact evaluation utilized a matched-groups comparison wherein the intervention group, (the participants) was matched to a similar group of students who participated in STEM-Connect courses but did not enroll in the STEM-Connect program. Insufficient numbers of participants, particularly when disaggregated by certificate of enrollment and the demographic variables of age, dependents, veteran status, prior and education levels of parents caused the VDOL to suppress cells. The limitation of numbers of participants has prevented originally planned propensity score matching thus limiting any causal inferences from the data.

Data collection for the STEM-Connect participants was done by program staff in conjunction with the UVM registrar, UVM Office of Institutional Research, UVM Student Financial Services, and VDOL. All matching data was de-identified and consisted of the variables named above for demographic (enabling variables) and participation as well as participant outcomes. Data collection resulted in Excel spreadsheet records that were then transferred to an integrated SPSS data set suitable for statistical analysis. Data collected from university sources were reviewed by both the program data specialist and the evaluation team member designated for data checking. Discrepancies between program collected data and university system data were justified and corrected. Department of Labor data for the State of Vermont were subject to internal review and corrected for errors prior to submission to the program evaluation and the U.S. Department of Labor.

The outcomes measured for the study included counts of participants for each of the outcome variables specified by the Solicitation for Grant Applications (SGA) and enumerated in level 1, above. Additional outcomes for the Impact level 2 study included comparisons between participant and non-enrolled groups with respect to demographic variables, employment status, wages, employment and course grades earned.

Implementation Findings

Building Institutional Capacity

- The grant was used to build institutional capacity by developing leadership and new internal and external partnerships.
- This increased capacity includes new STEM Certificates, highly-involved faculty, twenty-two newly developed or enhanced courses, the delivery of course and support services, new collaborative relationships with UVM internal unit units and external partner organizations and increased public awareness of the University as a local resource for workforce training.

Key Steps Taken

Key steps taken to build capacity included:

- Developing recruitment strategies,
- Providing incentives for faculty to develop new certificates and courses,
- Submitting certificate proposals for approval through the University administration to the Faculty Senate,
- Testing courses and revising curriculum,
- Developing support services including off-site tutoring,
- Internship support,

- Prequalification of veterans' benefits, and,
- Engaging partners in applying existing protocols for skill assessment.

Important Partnerships

- Important external partnerships were developed with VDOL, Vermont Army and Air Guards, Vermont HiTEC, the Vermont Student Assistance Corporation, and many recruitment partners, including Vermont Works for Women, Associates for Training and Development, Refugee and Immigrant Service Provider Network (RISPNet), Vermont Vocational Rehabilitation Services and Creative Workforce Solutions.
- Internally, new working relationships were established with the UVM's Continuing and Distance Education Division (CDE) and Veterans Services.

Fidelity to Original Program Design

The original program design included an emphasis on workplace learning opportunities. This component was modified from a certificate requirement to an optional component. The reason for this change in the program design was that internships are an optional component of current engineering curricula at the University. UVM CEMS encourages workplace learning but recognizes that many of its non-traditional students were employed while in training. The original program design indicated that all certificates should be "stackable." As implemented the program consisted of four certificates, one with five separate but related tracks based on foundational courses – a feature that allows for students to efficiently earn more than one certificate.

Operational Strengths

Operational strengths included the central role of strong program leadership by the Dean of the College of Engineering and Mathematical Sciences and the close working relationship with the program director. Support staff in the roles of recruiters, counselors and course designers were essential and provided coherence in management and implementation. A clear focus on the goal of the development of institutional capacity to create and offer workforce training certificates embedded in the College's curricular offerings and thus achieve sustainability was a key operational strength. Leadership supported the program's steady development and implementation of the certificates in order to demonstrate the efficacy of the STEM-Connect design and establish a clear presence not only at UVM but throughout the state. In addition, the University of Vermont is the 'flagship institution' for the State of Vermont. As such, the University has the depth of academic knowledge and resources, Research I status, and visibility not found in other state institutions.

Operational Challenges

Implementing a unique program devoted to the development of 'stand-alone' certificates outside the degree granting system and its reward structure (even though they were designed to fit within the degrees) is by nature challenging. In this case the program had to educate other parts of the University about the program's benefits and constraints. Operationally, the program often had to create administrative systems that paralleled those designed for degree students, or arrange for UVM's administrative and operational units to work outside of their normal processes. There were also challenges associated with working with the target population. UVM is better positioned to prepare individuals for entry into higher levels, and help those who need to update or hone existing

job skills. UVM is not well positioned to support those who are not prepared for rigorous academics. And, as often happens in programs that must ramp-up quickly, there were examples where communication was lacking. UVM is a decentralized environment in which units share and manage information in unique ways.

Outcomes/Impact Findings

Level 1

Key outcomes of the program included the performance of participants on the nine (9) outcomes articulated in the SGA. These outcomes are summarized in Table 1.

Table 1: Key Outcomes

Outcome Measure	Number
Total Unique Participants Enrolled	311
Total Number of Participants Completing a TAACCCT-Funded Program of Study	75
Total Number of Participants Still Retained in Their Program of Study or Other TAACCCT-Funded Program	221
Total Number of Participants Earning Credit Hours	294
Total Number of Participants Earning Credentials	75
Total Number of Participants Enrolled in Further Education	0
Total Number of Participants Employed After TAACCCT-funded Program of Study Completion	10
Total Number of Participants Retained in Employment After Program of Study Completion	2
Total Number of Those Participants Employed at Enrollment Who Received a Wage Increase Post-Enrollment	48

- Seventy-five of the 311 enrolled participants successfully completed their programs of study. All 75 were undergraduate students.
- As of June 30, 2017, the end of the program period, 42 of the 221 participants still engaged in the program had only one course remaining to complete the certificate program in which they were enrolled. These 42 individuals may well complete the program within the first year following the funding period, bringing the total number of participants completing a TAACCCT-funded program of study to 117.
- Undergraduates completing certificates tended to view the programs as providing a distinctive competitive advantage, including increased knowledge and skill development relevant to the job market. Those currently enrolled, either as non-degree students or graduate students additionally viewed the certificates as supporting career change, “right-sized” for those who were not seeking a degree, and useful for providing credentials for further education.

Level 2

- The participant and non-enrolled samples were not significantly different on any of the background characteristics related to the outcomes as measured.
- Non-enrolled students out-performed participants with respect to wages earned in a typical quarter.
- There was no difference between participants and non-enrolled students with respect to employment status during the program.
- Participants outperformed non-enrolled students with respect to grade point average earned during the program.

Limitations

Both Implementation and Outcomes/Impact studies were subject to several limitations related to the characteristics of the data and program design. These limitations included:

- The primary limitation of the evaluation of the implementation is that it is based in self-report. Self-report is valuable for understanding the experiences and viewpoints of those involved with implementing this program, but are inherently limited in perspective. Care was taken to interview a full range of stakeholders across the years of the project, and incorporate multiple perspectives in the evaluation reporting.
- The primary limitation of the outcome/impact evaluation is the challenge of the small size of the state's population (626,000) and the resulting applicant pools, sample sizes and the existence of an appropriate control group.
- Another factor that affected the outcome/impact analysis is missing data from student records in both the participant and matched groups.
- In order to track outcome and background data from student records (some of which were a self-report questionnaire) the program relied upon participant and other student permission to release the social security numbers to the Department of Labor and complete the questionnaire. Approximately ten percent of these groups declined to supply social security numbers to the program. Approximately forty-three percent of participants failed to complete the data questionnaire.

Key Lessons Learned

- In a primarily undergraduate research university whose stated mission is not directly aligned with typical strategies employed by other TAACCCT grantees for adult, displaced workers, the program required a different approach. Its approach, to create certificates that had something to offer to both traditional and non-traditional students, heightened benefits for both groups.

- Significant time is required to implement a new program like STEM-Connect. New relationships often require a long time for meaningful collaboration to emerge, particularly when trying to reach new audiences and change perceptions. It will likely take a while for

the program benefits to fully surface and flourish and it is important to recognize the value of planting seeds and creating a strong and meaningful foundation.

- For workforce development, UVM is better positioned to prepare individual for entry into higher levels, and help those who need to update or hone existing job skills. The career maps accompanying the certificate descriptions in Appendix 2 illustrate a need for workforce development at the level that STEM-Connect provides. As a result of STEM-Connect, UVM is in a better position to prepare individuals for entry into higher levels of the workforce, and help those who need to update or hone existing job skills. Combined, the new certificates, new courses which incorporate more engaging instructional approaches, new relationships with those focused on workforce development, and new approaches to marketing are evidence of UVM CEMS' increased capacity and newfound commitment to serving needs in the local community and beyond.

- It is extremely difficult to overcome significant barriers for non-degree students in the University setting. The cost of tuition is a significant barrier to participation in this program and efforts by STEM-Connect to address this barrier, such as working to achieve prequalification of some certificates for veterans' education benefits through the Veteran's Administration and working with a partner that was able to provide limited scholarships could not fully remove this barrier – one that must be addressed in the future. UVM is not always perceived as a friendly campus for non-traditional students. While this is not fully understood, possible reasons include unfamiliarity with bureaucratic processes or online course platforms, lack of academic preparation, or time constraints. There are unique challenges for serving the veteran and National Guard populations. Guard members are deployable and often hesitant to commit to this type of program. In addition, funding from the Veterans Administration generally doesn't cover all the costs of certificate programs.

Implications for Future Research

- Future research suggested by the STEM-Connect experiment in building institutional capacity and creating partnerships at the university level should involve the interpretation of Department of Labor specified participant outcomes on a time scale appropriate for the four-year degree. Lengthening the expected time period from three to six years would place the evaluation on a time scale appropriate to graduates' ability to enter the job market. Likewise, the measure of wage/salary outcomes should reflect the time period for market entry that is realistic for the four-year participant enrollment.

- Institutional change study designs (implementation) should engage four-year institutions in identifying what changes the institutions are committed to making and articulate the evaluation/research design on a time frame appropriate to the pace of change which is normal and reasonable for four-year institutions. In other words, for the Department of Labor or similar sponsors to facilitate growth and change in university contributions to the economy through workforce development, solicitation offerings should accommodate a time scale and institutional change strategy that fit the context of university development.

Introduction

STEM-Connect at the University of Vermont (UVM)'s College of Engineering and Mathematical Sciences (CEMS) is a four-year Trade Adjustment Assistance Community College and Career Training (TAACCCT) program designed to create certificates that provide clear and flexible pathways to employment in STEM-related fields needed in the Vermont economy. The program was designed to respond to the needs of both traditional and non-traditional student populations, especially those who were Trade Adjustment Assistance (TAA) eligible, veterans, dislocated workers, adults, underemployed or unemployed and those new to the STEM fields. The program sought to build the University's capacity to respond to rapidly changing technology related fields and to develop partnerships between the University and Vermont's business and industry.

Program Description and Activities

The program consisted of components that were built around stacked and latticed credentials (eight certificate tracks), enhanced, or newly developed traditional and on-line coursework in four academic areas, placement in workplace learning opportunities, recruitment, and student services. Certificate credentials included: Computer Software Certificates in Software Development, Web Development, Cybersecurity, Master's Preparation and Self Design; Computer-Aided Engineering Technology, Complex Systems (master's level), and Pre-Actuarial (Actuarial Science).

Program Model

Goals

The primary goal of the STEM-Connect program was to construct and test a model for STEM-related certificates at UVM that could be earned in two years or less, that would enhance academic offerings in STEM-related fields, and provide a vehicle for attracting and retaining both traditional and non-traditional students. In addition to providing opportunities for non-degree students, the program sought to accelerate the productivity of students enrolled in traditional degree programs by offering expanded Workplace Learning Opportunities (WLOs) and the opportunity to obtain credentials in less than two years along the traditional four-year educational pathway. A secondary goal was to broaden and deepen the University's outreach and partnerships with Vermont business and industry and state government in ways that would contribute to the economic well-being of the state and its citizenry.

Delivery

The delivery of the program consisted of regular credit-bearing academic course work, the mainstay of the university's delivery for degree programs, adapted for the narrower-scope certificates. Delivery also included the on-line course work and mentoring that better enabled participants who were non-traditional students to experience and master the content of STEM-related curricula in the above mentioned credential areas. Internships were coordinated through a statewide partner with direct access to Vermont industry (Vermont-HiTEC). Participant support

services consisted of the base support provided through University financial aid offices, counseling and career development at UVM. In addition, the program provided enhanced recruitment, counseling, tutoring and academic advising for participants who were non-traditional students in partnership with the University's Division of Continuing and Distance Education (CDE).

Content

The academic and job-related content of the program consisted of five areas of computer software, computer aided engineering technology, complex systems, and actuarial science. The certificates were designed within the eight areas so that participants could enroll in courses for one certificate or track and use some of those courses for a second or third certificate or track or as part of a degree program. This is what is meant by stackable and latticed. Detailed descriptions of the certificates are included in Appendix 2

Development with Partners

Course and certificate content were products of an iterative process which began when the program proposal was planned during the year prior to funding.

Figure 1 below shows the certificate launch dates, reflecting this iterative process as certificate programs were approved and begun.

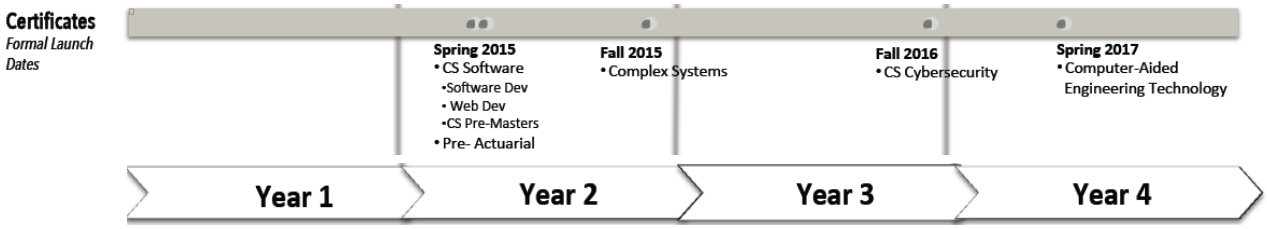

Figure 1: STEM-Connect timeline for certificate launch dates

Building something new required STEM-Connect leaders to reach out and form new relationships with local businesses, area non-profit organizations that serve the TAACCCT program's target population, and the VDOL. Additionally, the common goal of serving non-traditional students catalyzed increased communication and coordination between CEMS and service units within the university. Building new relationships with a strong network of partners, defined here as organizations and entities with overlapping missions both within and external to UVM, was foundational for the program. Internal partners included the College of Engineering and Mathematical Sciences (CEMS), Continuing and Distance Education (CDE), Veterans Services, Career Center, Registrars' Office, and Institutional Research. External partners include VDOL, Community College of Vermont (CCV), Vermont Student Assistance, National Guard (Air and Army Guard), Vocational Rehabilitation, Vermont HiTEC (a non-profit workforce development organization), and community organizations such as Creative Workforce Solutions and Refugee

Resettlement Program/RISPNet. Interactions among these partners have brought new connections and therefore new avenues to connect with and support target populations and the business community.

Figure 2 below indicates the partner development process spanning the life of the program.

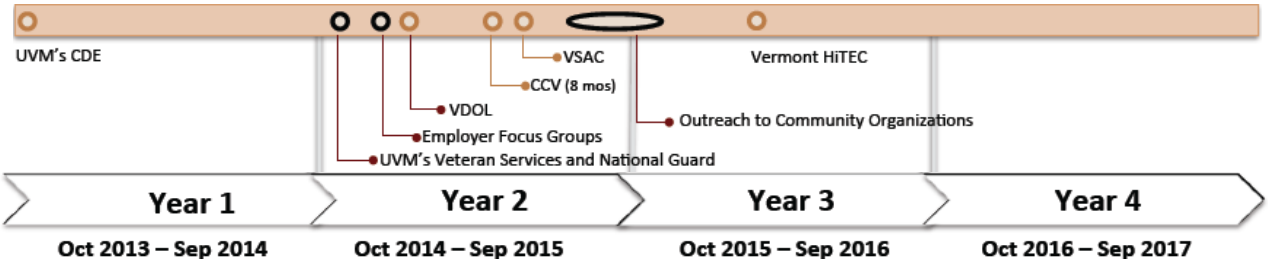

Figure 2: STEM-Connect timeline for building relationships to support participant engagement

Recruitment and Marketing

In the summer of 2014, still early in its implementation, the program took important steps toward enrolling participants and supporting them through completion of the certificate programs. In July of that year, the program hired an individual dedicated to employer outreach and participant recruiting. This individual developed a "dashboard" for tracking participant recruitment and the program began devoting time and resources to a participant recruitment plan which included coordinated, multi-media advertising, direct outreach activities by program staff, and agreements with partners to identify and connect with target populations.

These plans resulted in a steep ramp-up phase of recruitment marketing by summer 2015. This included an online presence for the certificate programs, local television (Vermont Public Television, WCAX), radio (WOKO, Vermont Public Radio), newspaper (Seven Days) advertising, bus signs, posters, and other printed materials. Online advertisements were placed on Hulu, Pandora Radio, Google Ads, and Monster.com. The certificate programs were also featured on the CEMS Facebook and Twitter feeds.

During 2015-16, the program deployed additional resources for recruitment. A staff member was added to focus on external recruitment so that the existing recruiter could concentrate on recruitments from within the UVM student population. Partnerships were also crucial for recruitment.

Program leaders worked directly with military and veteran partners at the Air and Army Guards and UVM's Veterans Services office to develop engaging and relevant promotional materials for veterans and have presented to military audiences about the certificate where staff trained to answer questions and connected potential participants with faculty advisors and/or the program's participant recruiter. CDE staff also tracked inquires and conversion (to enrollment) rates, sharing data with the program marketing team. The timeline below indicates the staffing and marketing activities as they unfolded.

In May 2016, Vermont HiTEC became a new recruitment partner. In addition to providing an onsite person to coordinate with program staff and develop a new data management system, Vermont HiTEC representatives worked with the program's external recruiter to reach out to local businesses and organizations, including the Air and Army Guard. New recruitment materials were designed and began being distributed regularly to external recruitment partners.

Figure 3 shows the building of capacity to support participant recruitment during the program period.

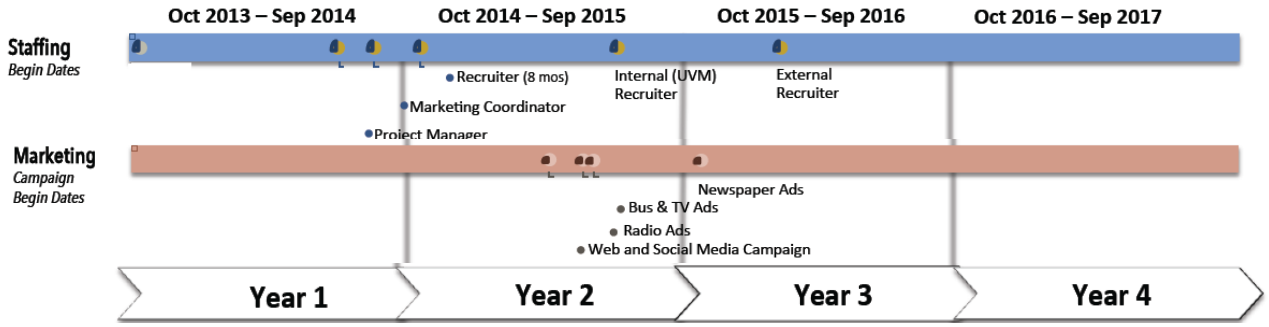

Figure 3: STEM-Connect timeline for building capacity and relationships to support marketing

Figure 4 indicates the numbers of participants who were recruited and later completed the certificates in which they were enrolled. Note that enrollments could begin only after new certificate programs were formally approved by the university.

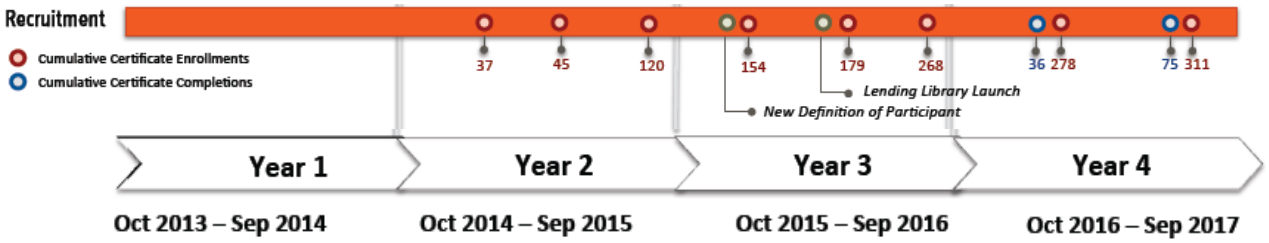

Figure 4: STEM-Connect enrollment timeline

Participant Characteristics

As the certificate programs were developed, they proved to be an attractive option for undergraduate students earning four-year degrees. Of the 311 participants, 265 (85%) were undergraduate students and 46 (15%) were either non-degree or graduate students.

One hundred and seventy-eight of the program's three hundred and eleven participants (57%) completed an on-line survey describing their employment and family background, how they heard about the program, and what they hoped to achieve by enrolling in a certificate program (See Appendix 3). The following composite portrait of a typical participant is drawn from responses to the survey, along with demographic characteristics and enrollment data provided by the program.

Portrait of Typical STEM-Connect Certificate Participant

The typical participant is a male traditional undergraduate student who learned about the certificate program through direct contact from one of STEM-Connect's recruiters – either by email, a class visit, or other informational meeting. He has a GPA greater than 2.87. As a full time student, he is most likely not employed, or if employed, is engaged part-time in conventional student employment, as for example a resident advisor, or research assistant. Already with some formal education in a STEM field, he has enrolled in a computer software certificate, focusing on web design, or preparation for a graduate degree, or in some aspect of computer software development. He is motivated to work toward the certificate by the overlapping aspirations of personal enrichment, improved skills and the potential for a better job. At least one of his parents has achieved a bachelor's degree or beyond. As a typical undergraduate, he has no one dependent on him for care.

To complete the participant picture, it is important to take into account, however, participants in certificates in pre-actuarial science, complex systems and computer-aided engineering design. Also, sizable portions of women, non-degree students and older, non-traditional students, many working in full-time jobs, complete the participant picture.

Participant Demographics

Table 2 below presents STEM-Connect participants' demographic information.

The data are consistent with the typical student described above – a traditional undergraduate enrolled in CEMS. It should be noted that the lack of TAA-eligible participants is consistent with the State of Vermont's demographics. According to information provided by VDOL, there were only 199 TAA-eligible individuals recorded in VDOL's database for the period from October 1, 2014 to June 30, 2017

Table 2: Participant Demographic Characteristics

Gender	Enrolled Count	Percent of Enrollments
Female	81	26.0%
Male	230	74.0%
Traditional (<=24) /Non-traditional Age	**Enrolled Count**	**Percent of Enrollments**
Non-Traditional	46	14.8%
Traditional	265	85.2%
GPA	**Enrolled Count**	**Percent of Enrollments**
>= 2.87 (mean GPA)	197	63.3%
< 2.87	100	32.2%
No data	14	4.5%
Race/Ethnicity	**Enrolled Count**	**Percent of Enrollments**
Hispanic/Latino	28	9.0%
Asian	13	4.2%
Black or African American	13	4.2%
White	200	64%
No data	50	16%
More Than One Race	7	2.3%
Other	**Enrolled Count**	**Percent of Enrollments**
Veteran	14	4.5%
Person with Disability	14	4.5%
TAA eligible	0	0%

Tables 3, 4, and 5 present the participant population, compared to the portion of participants who completed the online survey with respect to the certificate in which they enrolled, enrollment type, and certificate completion status. While we cannot be certain that the survey responders are representative of the total population, the tables indicates that the responders closely mirror the overall population with respect to these characteristics.

Table 3: Participants by Certificate

Certificate/Track	Enrolled Count	Percent of Enrollments	Survey Responder Count	Percent of Responders
Actuarial Science	18	6%	12	7%
Computer Aided Engineering Design	10	3%	1	1%
Complex Systems	12	4%	10	6%
Computer Software (CS) - Master's Preparation	43	14%	27	15%
CS - Self Designed	4	1%	2	1%
CS - Software Development	71	23%	29	16%
CS - Web Development	128	41%	80	45%
CS - Cybersecurity	25	8%	17	10%
Total	311		178	

Table 4: Participants by Enrollment Type

Enrollment Type	Enrolled Count	Percent of Enrollments	Survey Responder Count	Percent of Responders
Non-degree Student	36	12%	25	14%
Graduate Student	10	3%	9	5%
Undergraduate Student	265	85%	144	81%
Total	311		178	

Table 5: Participants by Completion Status

Completion Status	Enrolled Count	Percent of Enrollments	Survey Responder Count	Percent of Responders
Completed Certificate	75	24%	57	32%
Withdrew from Program	15	5%	12	7%
Did Not Meet Grade Requirements	26	8%	10	6%
Currently Enrolled	195	63%	99	56%
Total	311		178	

Figures 5 and 6 below, present data from the participant online survey that show the parent level of education (a proxy indicator of Socio-Economic Status) and employment status of participants as they entered the program. These data are also consistent with the undergraduate status of most participants. Most come from homes where at least one parent has a bachelor's degree or greater. And, most are working part-time, or unemployed and not seeking a change in their employment status.

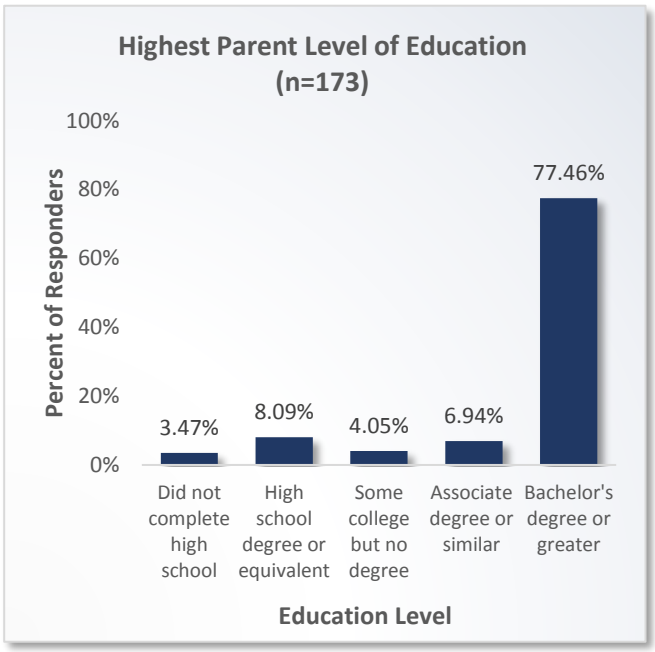

Figure 5: Most participants have at least one parent with a bachelor's degree.

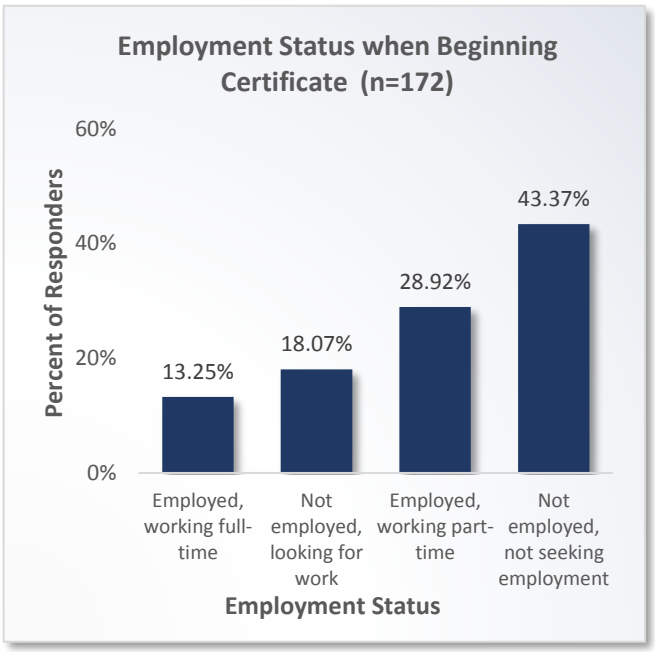

Figure 6: Most participants were not seeking employment when they began.

Evaluation Design

The purpose of the STEM-Connect evaluation was to determine the extent to which the University of Vermont's College of Engineering and Mathematical Sciences (CEMS) implemented the program plan for STEM-Connect, to determine whether the program expanded and improved CEMS's ability to deliver education and career training programs in STEM-related fields, and to determine the extent to which outcomes specified by the program were realized by the target population.

To achieve these purposes, the evaluation included both an implementation study and an outcome/impact study. The implementation study, described below, was guided by the program logic model and included several sources of data to inform its findings. The outcome/impact study included the collection of descriptive information and a comparison of STEM-Connect certificate participants with students that enrolled in a TAACCCT-funded course only as part of their regular university program without enrolling in STEM-Connect. Random assignment was not a viable alternative; the number of participants (311 in total; 75 completing their program of study) was not large enough to obtain appropriate levels of statistical significance.

Implementation Study Design

Conceptual Framework

The conceptual framework that guided the formulation of research/evaluation questions for the implementation study is expressed in the program Logic Model. The STEM-Connect theory of change in individual behavior involving the learning of new knowledge, skill and predisposition to act in ways that are consistent with employability and personal success is best expressed by the horizontal and vertical transfer models developed by Bruce Joyce and Beverly Showers (1983)[2]. The model described in the referenced training literature builds upon the developmental learning theories of John Dewey and Jean Piaget as articulated by David Ausubel[3], requiring a sequential approach to learning that embeds:

- the rationale (theory) of the new knowledge or skill or behavior, with a demonstration of its use, initiates,
- practice of the essential elements followed by feedback to the student on his/her performance and concluding with,
- coaching to mastery of the knowledge, skill or new behavior.

The 'scaffold' upon which curriculum is built and student experience structured is a step by step sequence of direct student involvement in learning and constructing a personal reality. The program Logic Model describes the program process as a series of steps which move dynamically (vertically and horizontally) through Resources/Inputs, to Activities, to Outputs, Outcomes and Impacts. Evaluation measures are linked to each component of the logic model and sequenced to provide real time analysis and reporting of program development. Figure 7 below shows a simplified logic model, presented in more detail in Appendix 1.

For the purpose of the implementation study, capacity was defined as the "emergent combination of individual competencies, collective capabilities, assets and relationships that enables an organization or other system to accomplish a purpose and create value"[1]. Thus, the measurement of capacity building included the products of the program (stackable certificates, marketing and publicity materials), the numbers of participants enrolling in the certificate programs, participant satisfaction with the program, relationships and services put into place, and the perception of key stakeholders of the extent to which capacity had been achieved and the prospects for sustainability.

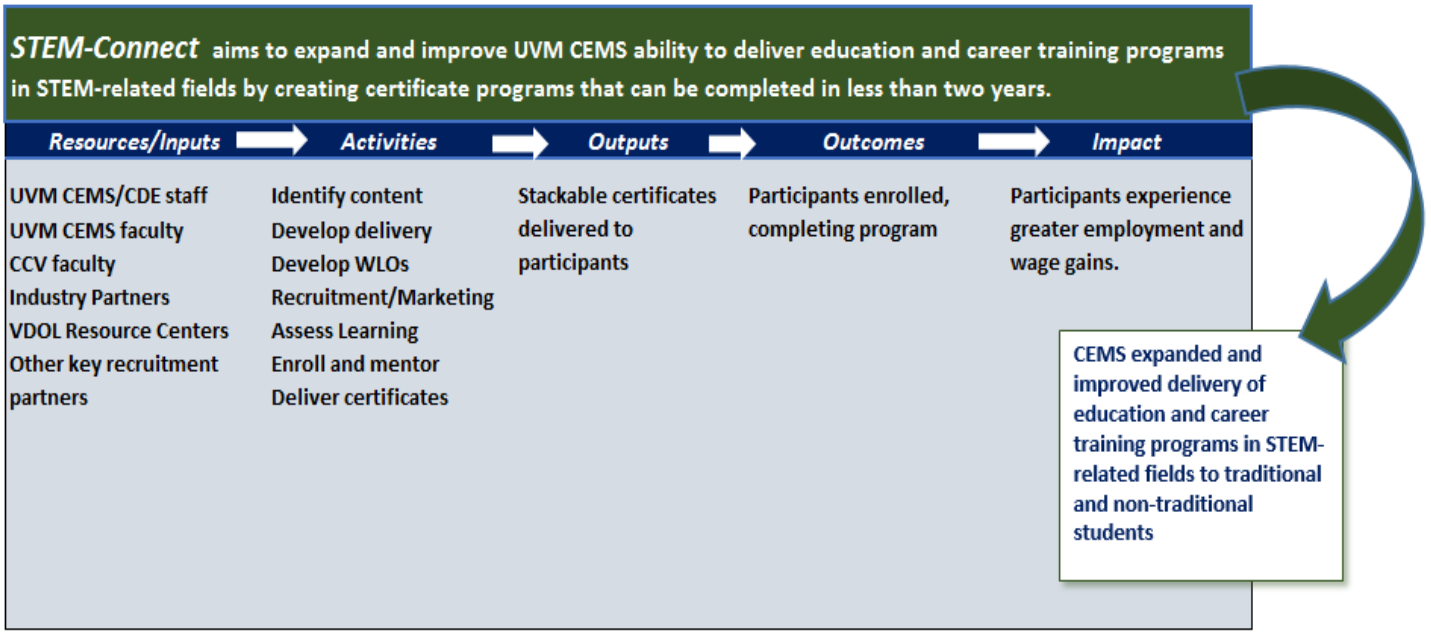

Figure 7: Logic model summary

Implementation Analysis Research Questions

Solicitation Research Questions

1. *How was the particular curriculum selected, used, or created?*
2. *How were programs and program design improved or expanded using grant funds? What delivery methods were offered? What was the program administrative structure? What support services and other services were offered?*
3. *Did the grantees conduct an in-depth assessment of participant's abilities, skills and interests to select participants into the grant program? What assessment tools and process were used? Who conducted the assessment? How were the assessment results used? Were the assessment results useful in determining the appropriate program and course sequence for participants? Was career guidance provided and if so, through what methods?*
4. *What contributions did each of the partners (employers, workforce system, other training providers and educators, philanthropic organizations, and others as applicable) make in terms of: 1) program design; 2) curriculum development; 3) recruitment; 4) training; 5) placement; 6) program management; 7) leveraging of resources; and 8) commitment to program sustainability? What factors contributed to partners' involvement or lack of involvement in the program? Which contributions from partners were most critical to the success of the grant program? Which contributions from partners had less of an impact?*

The solicitation-specified research questions provided the foundation for the implementation analysis, which is organized around the following framework of inquiry:

1. How and to what extent did STEM-Connect build institutional capacity?
2. What key steps did STEM-Connect take to implement the program?
3. To what extent and how were important partnerships formed?
4. What modifications to the original program design were made to accommodate new or unanticipated situations?
5. What were the program's operational strengths and challenges?

Implementation Data Analysis Strategies

The implementation study used a phenomenological approach to focus analysis. Strategies included interviews, documents analysis and consultations with program staff designed to check the alignment of the components implemented and resources allocated with those proposed[4]. Formative evaluation was communicated to program management both informally and formally with recommendations to improve program design and implementation. Summative evaluation focused on descriptive analysis of the process of implementation and assessed operational strengths and challenges.[5]

Implementation Data Collection

Sources of data for both formative and summative analysis included meeting observations, review of program and University documents including program communications, marketing and recruitment material, course materials, certificate proposals used for university academic program approval, job maps, internal reports and quarterly and annual program reports to funders.

In addition, interviews were conducted according to the following schedule:

Table 6: Interview Schedule Years 2-4

Grant Year	Type of Interviewee	Number
Year 2 (2015)	Program Leaders, Staff, & Consultants	5
	Program Partners	7
	Course Instructors	5
Year 3 (2016)	Program Leaders, Staff, & Consultants	5
	Program Partners	10
	Course Instructors	7
Year 4 (2017)	Program Leaders, Staff, & Consultants	4
	Program Partners	6
	Course Instructors	1
	Current and Completed Participants	24

In Year 2, evaluators began semi-structured interviews with program leadership and administration, instructors, course developers, individuals providing technical assistance for online instruction, and those responsible for participant advising, internship coordination, employer outreach, participant outreach, and marketing. Additional interviews were conducted with Community College of Vermont and Vermont Student Assistance Corporation partners.

During Year 3, evaluators completed additional semi-structured interviews. The majority of these interviews were with University of Vermont faculty and staff, including program leadership and administration, course instructors, course and certificate developers, and those responsible for participant enrollment and advising, internship coordination, employer outreach, participant outreach, and marketing. Additional interviews were conducted with Vermont Student Assistance Corporation, Vermont HITEC and VDOL partners.

During Year 4 evaluators completed 35 semi-structured interviews. These included a series of group interviews with program leadership and key staff focusing on research questions delineated in the SGA, and individual interviews with program staff responsible for marketing, recruitment, and data management, a course instructor, and partners including Veterans' Services, CDE, Vermont HiTEC, and VDOL, as well as 24 interviews with participants.

The above data sources as well as extensive conversations with program management form evidence for the implementation findings.

Outcomes/Impact Study Design

Goals of the Outcome/Impact Evaluation

The goal of the outcome/impact evaluation was to determine whether the program achieved its expected participant outcomes as detailed below in Table 7 including number of enrollments,

completions, retentions, obtained credit hours, credentials, higher education enrollment (post completion), employment, and wages.

Table 7: STEM-Connect Expected Participant Outcomes

	Outcome Measure	Annual Targets for all Participants		Totals
1	Total Unique Participants Enrolled	Year 1	30	150
		Year 2	50	
		Year 3	70	
2	Total Number of Participants Completing a TAACCCT-Funded Program of Study	Year 1	0	135
		Year 2	50	
		Year 3	85	
3	Total Number of Participants Still Retained in Their Program of Study or Other TAACCCT-Funded Program	Year 1	2	7
		Year 2	2	
		Year 3	3	
4	Total Number of Participants Completing Credit Hours	Year 1	30	146
		Year 2	46	
		Year 3	70	
5	Total Number of Participants Earning Credentials	Year 1	0	135
		Year 2	50	
		Year 3	85	
6	Total Number of Participants Enrolled in Further Education	Year 1	0	24
		Year 2	0	
		Year 3	24	
7	Total Number of Participants Employed After TAACCCT-funded Program of Study Completion	Year 1	0	116
		Year 2	50	
		Year 3	66	
8	Total Number of Participants Retained in Employment After Program of Study Completion	Year 1	0	116
		Year 2	50	
		Year 3	66	
9	Total Number of Those Participants Employed at Enrollment Who Received a Wage Increase Post-Enrollment	Year 1	0	15
		Year 2	5	
		Year 3	10	

Design of the Outcomes/Impact Evaluation

The design of the outcomes/impact analysis of the STEM-Connect program was a mixed-methods, non-experimental, qualitative and quantitative approach to the research/evaluation questions posed below.[6] Vermont is a very small state with respect to its population and labor market. Opportunities to populate training programs to enable comparisons of groups formed by intervention type and level are limited. The numbers of participants that were enrolled in the program necessitated limiting the comparisons to univariate analysis of outcomes for each of the intervention and control groups. The intervention group, referred to throughout the evaluation as participants, was matched to a similar group of students who participated in STEM-Connect courses but did not enroll in the STEM-Connect program. The matching of these groups enabled

group comparisons between STEM-Connect and other UVM participants on the above outcomes to determine the extent to which outcomes obtained by participants exceed those of a similar (demographic) statewide population. In addition, cohorts of STEM-Connect participants at Years 1-3 were followed longitudinally with a pre and post "slope greater than zero" basis. In particular, those program outcomes noted below as "enabling outcomes" tracked in a time series design with statistics appropriate to matched pair comparisons, both parametric and non-parametric as appropriate to the level of measurement. Other outcomes are reported as descriptive data and compared with Vermont population samples as benchmarks.

Level 1

The Outcome/Impact Study began with the collection and analysis of descriptive data and focused on the question of the extent to which the program recruited and enrolled program participants who met program requirements.

It also includes content analysis of interviews conducted with a sample of participants to assess participant perception of the program's actual or anticipated effect on employment and earnings.

Level 2

A matched-groups comparison of the STEM-Connect participants (intervention) and a control group was employed to estimate the contribution that the program made to the nine outcomes above.

The specifications of the matched-group evaluation design were as follows:

> ***Source and size of the comparison group:*** Students who enrolled for courses required for the STEM-Connect certificates but who did not enroll in any of the certificates constituted the comparison group. The number of these students available for comparison when the program ended was 2088.
>
> ***Sample selection and matching:*** Enrolled students were matched with the above comparison group and the results of matching were assessed for comparability on age, gender, family background and financial aid eligibility.

Outcomes/Impact Data Collection

Data collection for the STEM-Connect participants was done by program staff in conjunction with the UVM registrar, UVM Office of Institutional Studies, UVM Student Financial Services, and VDOL. All matching data was de-identified and consisted of the variables named above for demographic (enabling variables) and participation as well as participant outcomes. Data collection resulted in Excel spreadsheet records that were then transferred to an integrated SPSS data set suitable for statistical analysis. Data collected from the university registrar were reviewed by both the program data specialist and the evaluation team member designated for data checking. Discrepancies between program collected data and university system data were justified and corrected. Department of Labor data for the State of Vermont were subject to internal review and corrected for errors prior to submission to the program evaluation and the U.S. Department of Labor.

Outcomes/Impact Analysis Research Questions

The principal outcomes analysis questions are designed to evaluate whether the program achieved the expected outcomes described in Table 8. Thus, the descriptive section of the Outcomes/Impact study includes nine Level 1, descriptive questions focusing on these outcomes. These outcome measures were applied to the general question stem: How many (e.g., total unique participants were served)? Thus nine research/evaluation questions resulted.

Table 8: Outcome measures

Outcome Measure
Total Unique Participants Enrolled
Total Number of Enrollees Completing a TAACCCT-Funded Program of Study
Total Number of Enrollees Still Retained in Their Program of Study or Other TAACCCT-Funded Program
Total Number of Enrollees Earning Credit Hours
Total Number of Enrollees Earning Credentials
Total Number of Participants Enrolled in Further Education
Total Number of Enrollees Employed After TAACCCT-funded Program of Study Completion
Total Number of Enrollees Retained in Employment After Program of Study Completion
Total Number of Those Enrollees Employed at Enrollment Who Received a Wage Increase Post-Enrollment

The analysis looks at totals for the entire program period, without taking into account annual targets. It was expected that annual targets would be adjusted as the program timetable evolved over the program period.

In addition to the Department of Labor-specified program outcomes, the evaluators identified several enabling outcomes that served as dependent variables for the outcome evaluation to determine the potential effects of enrollment in the STEM Connect program. These outcomes are reported in the discussion of Level 2. Level 2 research/evaluation questions for these variables respond to the generalized question stem: "What was the difference in performance between enrolled and non-enrolled students for the period under review with respect to:" (e.g. wages earned, employment status, grades in courses, etc.). Level 2 questions included the following:

1. To what extent are the enrolled and non-enrolled (comparison group) different with respect to the background variables of gender, parents' level of education, age, and financial need (Bias testing question)?
2. To what extent does the STEM Connect program result in higher wages being earned relative to the comparison group?
3. To what extent does the STEM Connect program result in higher rates of employment relative to the comparison group?
4. To what extent does the STEM Connect program result in higher grade point averages relative to the comparison group?

Outcomes Data Analysis

Outcome analysis of the program focused on a quantitative estimate of the extent to which outcomes identified above were obtained by the participants (Level 1) and the extent to which the impact of the program may be estimated by comparison with a matched group (Level 2). The major hypothesis for the evaluation at the first level identifies the target outcomes as being obtained on a "slope greater than zero" basis, positive values increasing over time, with the significance calculated on paired comparisons (parametric or non-parametric as appropriate). Probability thresholds were set at the traditional $p<.05$, when sufficient power was present to estimate the chance variation in performance.

Study Limitations

The primary limitation of the evaluation of the implementation is that it is based in self-report. Self-report is valuable for understanding the experiences and viewpoints of those involved with implementing this program, but is inherently limited in perspective. Care was taken to interview a full range of stakeholders across the years of the project, and incorporate multiple perspectives in the evaluation reporting. The implementation findings are thus specific to this project.

The primary limitation of the evaluation of the outcome/impact is the challenge of small size of the state's population (626,000) and the resulting applicant pools, sample sizes and the existence of an appropriate control group. These limitations also provide a source of strength when describing the intervention and its outcomes. Vermont's relatively homogeneous population with respect to race, income and education provides some advantage when selecting benchmarks from the general population. At the same time, little is actually known about the rates of acceptance into employment and trajectories of occupations in the technology sector which are the targets of the STEM-Connect program. Vermont TAACCCT projects share these issues with STEM educational programs funded by both the National Science Foundation and the Mathematics and Science Partnership programs of the U.S. Department of Education. Evaluations of these programs provide considerable internal validity and reliability but are challenged by the generalization of impact.

Control group data consisting of demographic and outcome variables from participants matched on age, parents' education, gender and other demographic variables indicated above were obtained from UVM CEMS student files.

Other factors that affected the analysis include missing data from student records in both the participant and matched groups. With respect to the participant groups, the evaluation team worked with the administrative team to insure that complete data sets were obtained. With respect to the VDOL data on employment and wage related outcomes, the age and enrollment status of the primary participant population (undergraduates) limited the availability of the primary outcomes. For example, even though 2,205 participants and non-enrolled students appeared in VDOL data, only about 700 of these had wage-related data in any given quarter.

Another limitation was the fact that in order to track outcome and background data from student records (some of which were a self-report questionnaire) the program relied upon participant and student permission to release the social security numbers to the Department of Labor and complete the questionnaire. About ten percent of these groups declined to supply social security

numbers to the program. About forty-three percent of participants failed to complete the data questionnaire.

Implementation Findings

Introduction

The following implementation findings are based on interviews with program staff, partners, and participants over the life of the STEM-Connect program, along with review of course and materials, other program products and documents and program communications. Following a brief consideration of how the findings respond to the four SGA-specified research questions, the findings are developed more fully and organized into the following five categories. Pages that are particularly pertinent to each research question are noted, although the questions interrelate in many ways throughout the five categories elaborated.

1. Building Institutional Capacity
2. Key Steps to Run the Program
3. Important Partnerships
4. Modifications from Original Program Design
5. Operational Strengths and Challenges

A final discussion section expands on four crosscutting themes that emerged from the implementation study: *university setting*, *weaving new with existing structures*, *building relationships*, and *planting seeds*.

SGA-Designated Research Questions

1. *How was the particular curriculum selected, used, or created?*

   The grantee designed and implemented a process of curriculum creation that included recruiting faculty to design the materials, consulting with external partners to inform the content of the materials and developing detailed proposals to institutionalize the curriculum by submitting the curriculum to a university wide review and approval process. (Pages 26-29)

2. *How were programs and program design improved or expanded using grant funds? What delivery methods were offered? What was the program administrative structure? What support services and other services were offered?*

   Programs and program designs were improved and expanded using the grant funds to employ faculty and online course development support in the design process and by

using grant funds to enlist partners in collaborative program development and recruitment of students. Delivery methods included regular courses, on-line courses, tutoring, and internships. (Pages 29-36)

3. *Did the grantees conduct an in-depth assessment of participant's abilities, skills and interests to select participants into the grant program? What assessment tools and process were used? Who conducted the assessment? How were the assessment results used? Were the assessment results useful in determining the appropriate program and course sequence for participants? Was career guidance provided and if so, through what methods?*

   The grantees did conduct in-depth assessments of participant's abilities, skills and interests through recruitment and admissions processes for all undergraduates and through special services provided by partnerships with service units within the university and coordination with external partners. (Page 29).

4. *What contributions did each of the partners (employers, workforce system, other training providers and educators, philanthropic organizations, and others as applicable) make to the design and delivery of the program?*

   Each of the partners made significant contributions to the design and delivery of the program by participating either voluntarily (Vermont Works for Women, Associates for Training and Development, Refugee and Immigrant Service Provider Network, Vermont Vocational Rehabilitation, Vermont Student Assistance Corporation, veterans counseling, Continuing and Distance Education) or under contract (Vermont HiTEC, and Vermont Department of Labor). Contributions included recruiting, marketing, program design, internship placements, counseling and tutoring. (Pages 32, 34, 35)

Building Institutional Capacity

STEM-Connect met its primary goal of building UVM CEMS' capacity to respond rapidly to changing technology related fields and to develop partnerships with Vermont business, industry, and the Vermont Air and Army Guards.

Findings

UVM CEMS increased its capacity to meet workforce development needs by:

- Developing new STEM-focused academic certificates that benefit both traditional and non-traditional students.
- Creating four new courses and enhancing 18 existing courses (online and/or updated).
- Delivering courses and support services to both traditional and non-traditional students.
- Building new relationships with other organizations promoting workforce development in Vermont both to inform certificate development and reach out to adult learners, including those in the TAACCCT target populations.
- Through extensive marketing, increasing general public awareness of UVM as a local resource for workforce training.

New STEM-Focused Certificates

Based on input from Vermont businesses, the Vermont Air and Army Guards, and UVM faculty, STEM-Connect leaders completed the first work plan activities by designing four new STEM-focused certificates programs, one of which has five separate tracks, so that it is now possible for students to select from eight distinct new academic certifications. The rigorous certificate development and approval process at UVM includes reviews at multiple levels of the institution, including the Faculty Senate and the Board of Trustees. These processes, although they take many months to complete, help to ensure relevant, high quality content and instruction. Certificates in the following areas were developed and approved over the life of the grant:

1. Actuarial Science
2. Computer Aided Engineering Technology
3. Complex Systems
4. Computer Software (five tracks)
   (1) Master's Preparation (2) Self-Designed
   (3) Software Development (4) Web Development
   (5) Cybersecurity

These certificates were built on the foundation of existing courses or course sequences, and designed so that participants can complete them in two years

STEM-Connect
Work Plan Activities

1. Identify and develop stackable certificates aligned with employer needs.
2. Develop courses to support stackable certificates.
3. Develop infrastructure to support workplace learning opportunities.
4. Perform outreach to recruit adult learner participants including TAA-Eligible workers, unemployed and underemployed individuals, and veterans.
5. Enroll, place, and mentor participants.
6. Deliver certificate education through classroom, online, and work-based learning.
7. Perform management oversight, grant reporting, monitoring, fiscal management and evaluation of outcomes (program administration).

or less. Building from existing sequences created buy-in from faculty who already understood the relevance of the content they teach to future employability, and were excited for the opportunity to redesign course offerings to now also reach non-traditional students. This approach also ensured that any new development would be integrated into existing structures within CEMS, thus making it more likely to sustain beyond the life of the grant. In fact, in interviews faculty describe themselves as "academic champions" for the certificates developed with grant funds. It appears that not only the new certificates, but also the process of certificate development will be sustained beyond the life of the grant. Successful collaboration between UVM CEMS faculty and the business community has led to discussion around development of additional certificates in the areas of biomedical, computer simulation, and computer fluid dynamics. STEM-Connect leadership also reports that other colleges at UVM are now expressing interest in developing their own certificate programs.

Each certificate is comprised of five three-credit courses. Most of the courses in these new certificates are available online. These certificates are stackable in the sense that their content is inter-related, and some of the individual courses count toward more than one certificate. The courses also count toward academic minors, majors, culminating in Bachelor of Science or Arts and/or Master of Science or Arts degrees. For non-traditional students, these certificates serve as stand-alone credentials they can use to increase their employment options. For traditional students, earning certificates as part of working toward a bachelor degree is useful in obtaining internships prior to graduation as well as a way to highlight specific skills upon graduation and entry into the labor force.

Creating New Courses and Enhancing Existing Courses

As shown in Table 9 on the following page, to address the second work plan activity, UVM CEMS leadership and faculty created four new courses and enhanced eighteen existing courses, thus increasing capacity to serve a broader range of students and workforce needs. New course development was necessary for the Cybersecurity Certificate because prior to the STEM-Connect grant, student access to cybersecurity content was limited to higher-level computer science courses or to students interested in research and development. From conversations with employers, and especially with the Vermont Air and Army Guards, the need for introductory, application-focused cybersecurity courses became evident. Grant funds were used to develop four new cybersecurity courses, all of which are available online. Two are non-technical introductory courses: *Exploring Cybersecurity* and *Cybersecurity Law and Policy*. The other two, *Applied Cybersecurity I* and *II*, are technical, and have a prerequisite of one basic programing course. These new courses are the foundation for a new cybersecurity curriculum that will eventually extend beyond the certificate. UVM CEMS has recently hired new faculty to support this development, and all courses are designed using guidelines from the National Security Agency with the goal of achieving certification as a National Security Agency Center of Academic Excellence in Cyber Defense.

Eighteen existing CEMS courses were made more broadly accessible through the grant, in terms of both format and instructional approach. Sixteen of these are now available online, and instructors reported that the process of developing their content for online options enhanced their on-campus offerings as well. Lecture and exam review videos are now available to students, whether they are in an online or in-person section of a course. Instructors received support from instructional designers and online courses were developed from the same basic course "shell" to

reduce time returning students need to become familiar with the online environment – something instructors report is particularly important for non-traditional students. Instructors also talked of how watching themselves on video inspired them to revise some of their lectures, edit videos to clarify explanations, or otherwise improve their instruction. One mentioned consensus among participating faculty that STEM-Connect made it possible for them to implement changes they had long been considering, but had previously not had the time to fully develop.

An example of change in instruction was in the *Computer Organization* course. Until last year, this core required course in the computer science department was a highly theoretical, lecture-based course that consistently received negative student course evaluations. One faculty member who has extensive experience with workforce development was asked to cover this course, and agreed to also redesign it. The new version, which was piloted in spring of 2017, explicitly connects theory and application using the Raspberry Pi (www.raspberrypi.org) as an instructional medium. Each student had use of one of these micro-computers, and approximately half of class time is now devoted to labs or projects which include writing and running assembly language programs. This shift in instructional approach was highly engaging for students, whose evaluations for this version of the course were positive. Some even requested to purchase the Raspberry Pis to continue development on their own. Beyond engaging students, this approach to instruction is also responsive to employer concerns that UVM undergraduates often enter the workforce unable to apply their theoretical understanding to solve actual workplace problems.

Table 9: Courses Developed or Enhanced through STEM-Connect

Course	Title	New	Enhanced	Online
CEMS 095/295	Interactive Design		X	X
CIS 096	Cybersecurity Law & Policy	X		X
CS 005	Cybersecurity: Intro & Exploration	X		X
CS 008	Intro to Web Site Development		X	X
CS 008	Intro to Web Site Development		X	
CS 021	Computer Programming I: Python		X	X
CS 110	Intermediate Programming: Java		X	X
CS 121	Computer Organization		X	
CS 142	Advanced Web Design		X	X
CS 148	Database Design for the Web		X	X
CS 195 (CS 166)	Applied Cybersecurity I (Cybersecurity Principles)	X		X
CS 195 (CS 167)	Applied Cybersecurity II (Cybersecurity Defense)	X		X
CSYS 266/MATH 266	Chaos, Fractals & Dynamical Systems		X	X
CSYS 300/MATH 300	Principles of Complex Systems		X	X
CSYS 303/MATH 303	Complex Networks		X	X
EC 011	Principles of Macroeconomics		X	X
EC 012	Principles of Microeconomics		X	X
ENGR 002	Graphical Communication		X	X
ENGR 195	Fundamentals of Labview		X	X
MATH 183	Fundamentals of Financial Math		X	X
STAT 151	Applied Probability		X	X
STAT 183	Statistics for Business		X	X

Course Delivery and Support Services for Traditional and Non-Traditional Students

In addition to the new certificates, and new and enhanced courses, STEM-Connect offered program participants access to services above and beyond those offered to traditional on-campus students and for non-degree seeking students through CDE. Actions to fulfill the third, fifth, and sixth work plan activities include running the courses described above, and also establishment of a lending library, off-site tutoring, internship support, and prequalification of certificates for veteran's education benefits through the Veteran's Administration. Assessment of non-traditional student ability, skills, and interests was conducted by program partners VDOL, Vermont Student Assistance Corporation, and UVM's CDE using their existing protocols. While this assessment was of some value to non-traditional students, most participants were UVM undergraduates who had undergone a rigorous application process prior to matriculating at the university, and for this group the program deemed that additional assessment prior to enrollment in the certificate programs was unnecessary.

Lending Library: Textbooks for many of the courses in the certificate programs are prohibitively expensive. To address this barrier to enrollment, STEM-Connect leadership established a lending library. Students who enrolled in a certificate program had free use of required textbooks for the duration of a course. For some students this was so valued that it became an incentive for enrollment in the certificates.

Tutoring: In addition to the tutoring generally available to all students enrolled in UVM courses, certificate course instructors shared stories of the extra efforts they made to connect especially with non-traditional students. In one example, a teaching assistant offered to meet a group of non-traditional participants all from one organization at or near their workplace. Several instructors talked of meeting with students through online formats rather than expecting students to come to traditional office hours.

Internships and Career Counseling: STEM-Connect staff and partners shared information with participants about available internships. Participants who were interested in applying or were accepted into internships were mentored by partner organization staff with expertise in workforce development. Staff and partner representatives integrated career counseling with their recruitment efforts, and continued to be available to participants who sought advice after enrollment in a certificate.

Pre-Qualifying STEM-Connect Certificates with the Veterans Administration: STEM-Connect staff worked with UVM's Veterans Services Coordinator to prequalify the new certificates for education funding through the Veterans Administration. Generally such requests are not made until a veteran seeks to use benefits for a particular program. The process can be lengthy. Prequalifying allows veterans who wish to use benefits to cover the cost of enrollment in STEM-Connect certificates can now do so right away.

Building New Relationships

In addition to building external relationships for the purpose of creating relevant and responsive certificate programs, STEM-Connect formed new connections with VDOL, Vermont Army and Air Guards, and local non-profit organizations whose mission involves work force development. Aligned with the fourth work plan activity, these new relationships helped the program recruit participants from TAA-eligible populations, unemployed and under-employed individuals, and veterans. Program leadership made initial connections with some of these organizations, and eventually other staff and consultants/partners extended the network of connections. Additionally, the common goal of serving non-traditional students catalyzed increased communication and coordination between CEMS and service units within the university, including Veterans Services as described in the section above. These partnerships will be discussed in more detail later in this report.

Marketing to Raise Awareness of UVM CEMS's Role in Workforce Development

STEM-Connect invested heavily in marketing the new certificate programs to a wide audience, and in the process increased UVM CEMS' capacity to raise awareness of its role in workforce development. Beginning in 2015, STEM-Connect initiated web and social media campaigns targeted at local, national, and international audiences. This was soon followed by advertising on local television and radio stations, in newspapers and on buses in communities near the UVM campus. Posters, flyers, and information sheets were designed, printed, and distributed to regional VDOL sites around Vermont, and delivered to partner organizations focused on recruiting participants. Marketing continued throughout the grant period, adjusted based on semester start dates and as new certificates were formally launched. Over time, staff involved in the marketing learned what was and was not effective. There is consensus among those interviewed that community members are much more aware of the certificate programs. Toward the end of the program, emphasis in the marketing efforts shifted toward engaging potential participants through social media – to build relationships around the CEMS's brand. The idea of building relationships through marketing is now being applied to other UVM CEMS degree programs, and includes new flyers targeted at drawing undergraduates from other UVM colleges into the certificate programs. An unanticipated impact is that another UVM college has begun to run advertisements that mimic those run by STEM-Connect.

Key Steps to Run the Program

Findings

UVM CEMS proved to be a learning organization, able to adapt the program over time to meet employer and participant needs, comply with university policies, and meet grant requirements.

As outlined in the program timeline (Figure 8) STEM-Connect took key steps in the areas of staffing and partnerships to develop and market certificates and ultimately engage participants. Each year of the program presented new challenges and opportunities.

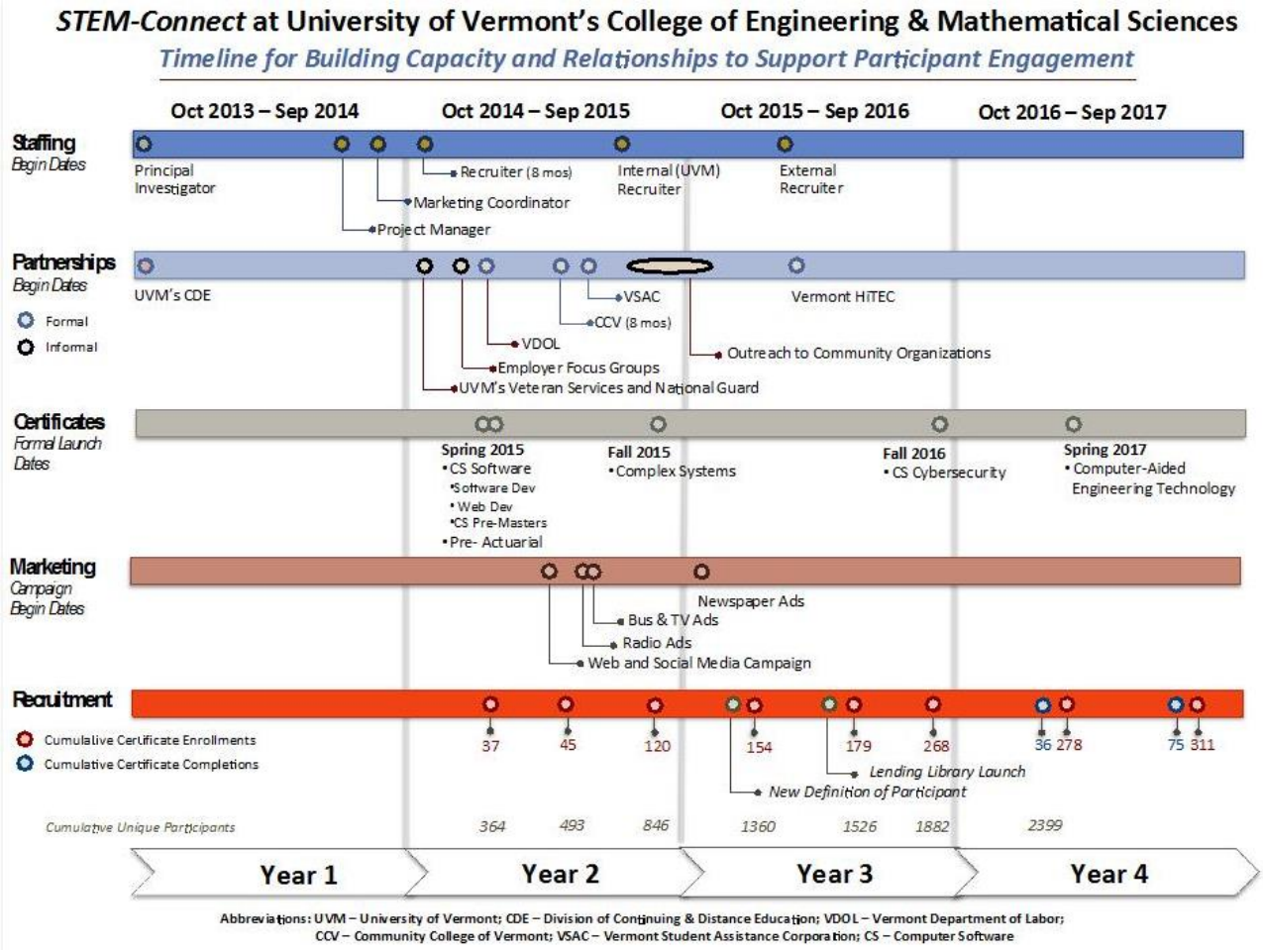

Figure 8: Program timeline

Year 1 – Establishing Leadership and Core Partner Responsibilities

STEM-Connect's leadership was and continues to be critical to the success and sustainability of the program. CEMS new Dean stepped into the role of Program Director after a personnel change within UVM between application and awarding of the grant. Under his leadership, a program manager was hired late in Year 1, and part of the existing CEMS communications director's time was allocated to marketing the new certificate programs. Since UVM's organizational structure distinguishes between degree seeking and non-degree seeking students, CEMS's initial core partnership was with CDE. This university division traditionally creates programs and manages enrollment for non-degree students, and at this stage it was anticipated that most participants would be non-traditional students. In Year 1, STEM-Connect and CDE leadership clarified roles and responsibilities related to employer outreach, development of new certificates, marketing, and

participant recruitment and enrollment. Breaking with tradition, the key decision was made that CEMS would drive development of the certificate programs to meet workforce development needs, and take the lead for marketing and recruitment. As a result, CEMS, an academic unit, and CDE, a support unit, had to establish new ways of sharing information, linking web sites, designing online courses, and supporting participants. Leveraging these existing structures - an academic unit and a service unit within the university – in a new way was critical to the long-term sustainability of new development through STEM-Connect. It allowed CEMS faculty and staff to really "own" the new development and be more intentional about designing courses that combine academic rigor with responsiveness to workforce needs, thereby improving their capacity to serve both traditional and non-traditional students. The shift ultimately strengthened the connection between CEMS and organizations outside the academic community.

Year 2 – New Partnerships and New Certificate Launches

Recruiters served in Years 2 – 4 as key liaisons with the business community, area non-profits serving the under-and unemployed, VDOL, and the UVM undergraduate population. They also directly recruited participants into the program, mentoring them through the application and registration processes. Focus groups and individual meetings with employers were held in several regions of Vermont to gather input for new certificates and build relationships to support both participant recruitment and future internship opportunities.

For the TAACCCT target audience, representatives of agencies that work with the under- or unemployed report that UVM is often perceived as "unattainable." Barriers include relatively high tuition and academic preparedness to succeed in rigorous academic settings. To address this challenge, the program manager established recruiting partnerships with local workforce development organizations including the Vermont Student Assistance Corporation, Vermont Works for Women, and Associates for Training and Development. Attempts were also made to work with Community College of Vermont to assess prospective enrollees' prior learning and build a pipeline of students prepared to participate in the certificate programs. The program manager also reached out to the UVM Veterans Services Coordinator and the Vermont Army and Air Guards to develop engaging and relevant promotional materials for veterans, and presented to military audiences about certificate opportunities. These efforts to build relationships were supported by the extensive marketing effort to raise awareness of the new CEMS certificates, and have potential to serve as the foundation for long-term workforce development networks beyond the grant period.

In 2015, the first three certificates - in actuarial science, computer software, and complex systems - were formally launched. STEM-Connect leaders strategically chose to begin certificate development by enhancing pre-existing course sequences in these areas so they could be shepherded more quickly through UVM's extensive design and review process. Approval for certificates that include new course development is more difficult. The process of establishing formal new certificates required substantial time and effort on the part of program leaders. Since university policy prohibits advertising for certificates prior to formal approval, it was important to prioritize those certificates that could be developed more quickly.

Year 3 – Focus on Recruitment

As progress on certificate development continued in Year 3, including formal launch of the cybersecurity track of the computer software certificate, primary focus shifted to participant recruitment. After a site visit from program officers in December 2015, the program definition of participant expanded to include both traditional and non-traditional students. STEM-Connect leadership responded by expanding recruitment to matriculated UVM students. The program recognized that it did not yet have adequate capacity to reach the TAACCCT target audience, so it formed a new partnership with Vermont HiTEC, a non-profit with extensive experience working with local businesses to recruit and train employees. As mentioned earlier, a textbook lending library was established to serve as a recruitment incentive and lower the cost of participation.

Year 4 – Full Implementation and Completion of Deliverables

In spring 2017, the final certificate – in computer-aided engineering technology – was formally launched, exceeding STEM-Connect's commitment to develop at least five certificate programs. Focus on participant recruitment and support continued through June 2017. Rounding out the project's outreach to local businesses, partner Vermont HiTEC conducted an employer survey to inform future CEMS program development. Year 4 also included winding down administrative activities necessary for grant management and reporting.

Important Partnerships

Findings

The common goal of serving non-traditional students catalyzed increased communication and coordination between the CEMS and service units within the university.

UVM CEMS formed strategic partnerships with Vermont non-profit organizations that serve the TAACCCT program's target population, and the Vermont Department of Labor.

As described above, STEM-Connect worked in partnership with other organizations within and external to UVM to build the certificate programs and recruit and support participants. Key partnerships are summarized below.

Increased Collaboration between the CEMS and Service Units within UVM

Partnerships between CEMS and units within UVM were formed with CDE and Veterans Services.

Division of Continuing and Distance Education (CDE): CDE conducted market research to inform certificate development, supported CEMS faculty with instructional design expertise, and coordinated with the STEM-Connect communications director to build parallel web sites with a shared back end so that all inquiries and enrollment requests from non-traditional students were managed through one system. All non-degree students at UVM enroll through CDE, and its academic advisors are now trained to respond to inquiries about the certificates or set up connections with appropriate faculty in CEMS. CDE also modified its application process to meet STEM-Connect data collection requirements. Going forward, CDE will continue to market the certificates as part of its larger portfolio, and intends to continue building relationships initiated through STEM-Connect with VDOL and the veterans' community.

Veterans Services: The UVM Veterans Services office worked with STEM-Connect staff to secure pre-approval of the certificates for Veterans Administration education benefits. This is especially important in a state like Vermont that does not offer tuition reductions or waivers for those serving or who have served in the military. Tuition, as well as limited time, are reported as significant barriers to veteran participation in higher education. Pre-approval of the certificates potentially reduces both the cost and the time it takes for veterans to enroll in the certificate programs. The Veterans Services office also provided feedback on marketing materials early in the program.

Strategic Alliances External to UVM

To better reach and support the TAACCCT target populations, STEM-Connect also worked closely with VDOL and local non-profit organizations.

Vermont Department of Labor: Through it regional offices across the state, VDOL posts marketing materials about the STEM-Connect certificates at its Career Resource Centers. These materials are also included it its Rapid Response packets whenever area employers announce large layoffs. VDOL counselors met periodically with STEM-Connect recruiters to learn about the certificate programs, including prerequisite skills and potential career pathways. Going forward, VDOL has committed to continuing to distribute promotional materials and feature the certificates quarterly on its web site home page banner. VDOL was also a key partner is providing data for the outcome evaluation, discussed elsewhere in this report.

Vermont HiTEC: Vermont HiTEC, a non-profit that works closely with local businesses to prepare job-seekers for industry-specific employment opportunities, worked with STEM-Connect on participant recruitment, employer outreach and internships, and data management. Efforts to recruit from TAACCCT target populations included coordination with VDOL regional offices, and presentations at the Air and Army Guard facilities. To help address the barrier of high tuition, HiTEC secured scholarships for a computer science course for one group of Guard members. To help build capacity within CEMS, Vermont HiTEC staff mentored a CEMS external recruiter. A Vermont HiTEC staff member was also embedded in CEMS to conduct extensive data organization and management, which supported both reporting requirements and recruitment of UVM undergraduates into the STEM-Connect certificates. Vermont HiTEC identified internship opportunities and mentored students who obtained internships. Late in Year 4, one of its staff members conducted a survey of local employers to inform CEMS about next steps in development of programs that support workforce development.

Other Organizations Working to Build Education and Employment Opportunities: As noted in the section above on key actions taken to implement STEM-Connect, the program reached out to many local organizations that aim to improve education and employment outcomes for under-served populations. These organizations include Vermont Student Assistance Corporation, Vermont Works for Women, Associates for Training and Development, Refugee and Immigrant Service Provider Network (RISPNet), Vermont Vocational Rehabilitation, and Creative Workforce Solutions. These new partnerships have not immediately led to enrollments, but the CEMS certificates are now known and personal contacts have been established that reinforce messages more broadly disseminated through STEM-Connect's media campaigns.

Modification from Original Program Design

Findings

UVM requirements for course and certificate approval led to changes in how workplace learning opportunities were structured and how the certificates are stackable.

Change in the definition of participant to include traditional undergraduates increased the number of individuals who benefit from the certificate programs.

Workplace Learning Opportunities (WLOs)

While the original work plan called for WLOs to be integrated into the certificates, WLOs evolved to be optional components. This change reflects institutional constraints (WLOs for credit are not part of the CEMS curriculum) and the needs of non-traditional students, many of whom were already employed while enrolled. As described above, internships and career counseling were offered as benefits to enrolling in the certificates.

"Stackable" Sequence of Certificates

The original program plan envisioned certificates that moved (stacked) in a sequence from (1) an initial four-course sequence to (2) internship/ co-op work or other WLO to (3) complementary general education courses. Instead, all the new STEM-Connect certificates are self-contained academic certificates. While not stackable as envisioned in the original grant proposal, these certificates are interrelated. They also build upon one another in cases where particular courses are required for and count toward more than one certificate. This change reflects the change in the approach to the WLOs and aligns with the University's current protocols for academic certificates. Each stand-alone certificate is also stackable in the sense that it is an important milestone on the path toward a bachelor's or master's degree.

Broader Definition of Participant

STEM-Connect proposed enrolling participants through CDE and monitoring and mentoring them from enrollment, through course work, WLOs, graduation and into employment. The development of process and procedure manuals for enrollment, monitoring, and mentoring participants were proposed to support these activities.

As enrollments began in year two, participants who fell into at least one of the following categories were considered participants:

- TAA eligible
- Underemployed
- Unemployed
- Displaced worker

- New to STEM
- Veteran
- Non-traditional student (24 years of age or older, independent)

Following discussions with Department of Labor program personnel during a monitoring visit in December of 2015, this definition was broadened to be more consistent with one of the proposal's stated goal to "*accelerate the productivity of students enrolled in traditional degree programs by offering . . . the opportunity to obtain stack able credentials in less than two years along the traditional 4-year educational pathway"* and with DOL's criteria for including participants in its reporting. In January of 2016 a new definition emerged and undergraduates enrolling in STEM-Connect's certificate programs were added to the definition. At that point in time, the program also began tracking UVM students who enrolled in STEM-Connect's courses as part of their regular program of study, but did not enroll in a STEM-Connect certificate program.

While this was not a modification in the original program design, with this change STEM-Connect began to focus recruitment on both traditional and non-traditional students. Enrollment of non-traditional students continued through CDE, while enrollment of traditional students was managed directly by CEMS faculty and staff.

Operational Strengths and Challenges

Findings

From the outset, new development by STEM-Connect was designed to be sustainable beyond the grant funding period.

STEM-Connect focused use of grant funds to build capacity and meet grant reporting and knowledge sharing requirements.

While challenged by operating outside of the normal UVM degree-granting structure and by an accelerated ramp-up following a delayed implementation, STEM-Connect made important steps to connect with the TAACCCT grant target audience; there is more work to be done on this front.

As noted earlier, CEMS has shown itself to be a learning organization, assessing needs and responding to changing contexts to build sustainable new academic certificates.

Strengths

Designed for Sustainability

As described above, the certificates developed through STEM-Connect were carefully woven into the fabric of CEMS, and are continuing beyond the life of the TAACCCT grant. The Dean and faculty see the value of these certificates for their traditional students, and are invested in helping them develop both theoretical knowledge and practical application skills for future careers in STEM. The content of the certificates is aligned to national and industry standards, and in the case

of cybersecurity forms the basis for a new area of development in the college. Both CEMS and CDE are committed to ongoing outreach to non-traditional students as well. Institutional structures also favor such outreach. Under a new university-wide budgeting framework called Incentive Based Budgeting, academic units are rewarded for high enrollment rates.

Capacity Building and Grant Reporting

Grant funds were carefully allocated to activities that built capacity and responded to grant reporting requirements. Even though, for example, marketing and advertising for the certificates will not continue at the same scale as was possible during the grant period, efforts during that period raised CEMS's profile in and beyond Vermont. Marketing in the future can build on this foundation. Similarly, STEM-Connect's program director and recruiters were "temporary" in the sense that their positions did not continue beyond the grant period, but their time and effort was necessary for the new development.

Also temporary, but critical for internal management and grant reporting, was STEM-Connect's contract with an external partner to organize and analyze data. The program has filed periodic reports to funders and has been supportive of evaluation activities, open with sharing information, and receptive to suggestions.

Challenges

Hurdles Associated with Implementing an Atypical Program

Challenges resulted from locating a program devoted to the development of 'stand-alone' certificates that were sometimes perceived as outside the degree granting rewards system (even though they were designed to fit within the degrees). The program had to educate other parts of the University about the program's benefits and constraints. Operationally, the program often had to create administrative systems that paralleled those designed for degree students, or arrange for UVM's administrative and operational units to work outside of their normal processes. These challenges are shared by other programs at the University that are devoted to developing skills and knowledge that lie outside of existing programs and are designed for non-traditional students.

UVM's Capacity and Commitment to Serving Non-Traditional Students

For workforce development, UVM is better positioned to prepare individuals for entry into higher levels, and help those who need to update or hone existing job skills. UVM is not well positioned to support those who are not prepared for rigorous academics or those transitioning from community college to UVM.

Communications

As noted in earlier evaluation reports, personnel changes early in the grant period led to delays in implementation of all aspects of the program. And, as often happens in programs that must ramp-up quickly, there were examples where communication was lacking. While steps were taken in the

last two years to streamline information sharing for participant recruitment and enrollment, UVM is a decentralized environment in which units share and manage information in unique ways.

Discussion of Implementation Findings

Notable Themes

As noted in earlier sections, STEM-Connect was awarded to a major land-grant institution with the primary mission of serving traditional full-time students. This institutional context, a *University Setting,* is an important theme that runs throughout the implementation findings. Closely related to this is a second theme of *Weaving New Initiatives* into the fabric of the existing institutional structures to ensure quality and sustainability. In order to build capacity that will sustain beyond the grant funding period, program leaders respected and leveraged existing institutional strengths to build rigorous academic certificates that serve the needs of both TAACCCT target populations and traditional undergraduate students. This new capacity, grounded in eight new professional certificate tracks that include new and enhanced university courses, was the result of intentional outreach and consultation with local businesses, non-profits, and VDOL. *Building New Relationships* both within and external to UVM bode well for ongoing collaboration aimed at workforce development and make up third theme in the STEM-Connect findings. A fourth theme encompasses the first three. Much careful foundational work was important and necessary in order to develop, implement, and integrate a unique program at UVM with new partners. Much of the work may be viewed as *Planting Seeds*.

These four overarching themes frame the “story” of STEM-Connect and resonate with the implementation findings.

University Setting

Unlike most TAACCCT grantees, principally community colleges, STEM-Connect was awarded to UVM, a major land-grant institution with the primary mission of serving traditional full-time students. This had important implications for program implementation, including partnership building, certificate development, and participant recruitment. For example, UVM’s organizational structure distinguishes between degree seeking and non-degree seeking students, so one of the key partnerships was within the university itself – between CEMS, the academic unit where the program was housed, and CDE, a service unit through which non-degree seeking students access UVM courses. The rigorous certificate development and approval process at UVM includes reviews at multiple levels of the institution, including the Faculty Senate and the Board of Trustees. While these processes help to ensure relevant, high quality content and instruction, comprehensive review can take many months to complete. As a result, enrollment in STEM-Connect certificates could not begin until well into the second year of the grant. Separate but simultaneous to implementation of STEM-Connect, UVM launched a new budgeting framework, known as Incentive-Based Budgeting, in which academic units are provided funds based on the enrollment in their classes. This new budget framework provided the financial resources for CEMS to offer new classes or sections of classes (the grant did not cover the cost of instruction) and recruit students to meet grant enrollment targets. For the TAACCCT target audience, however,

UVM is often perceived as “unattainable.” Barriers include relatively high tuition (currently each 3-credit course for in-state students costs $1,968) and academic preparedness to succeed in rigorous academic courses. Despite these barriers, UVM offers some singular advantages. These include access to professors with research and publication experience, access to current technology, access to advanced technology support services, perception of the certificates as rigorous and high quality, and ease of transfer from certificate to degree programs. For traditional students on campus, an unanticipated outcomes of the program included interim certifications that increased their opportunities for internships, as well as revised courses that integrate theory with project-based learning and took advantage of on-line learning tools.

Weaving New Academic Certificates and New Student Populations into the Fabric of UVM

This theme is closely related to the first. In an institution like UVM focused on serving traditional undergraduates**,** also serving non-traditional students with STEM certificates requires finding the overlap in the needs of both of those populations, while also building systems responsive to the unique needs of each group. The original design of the grant called for a separate program of stackable intermediate certifications for non-degree students, but the UVM certificate approval process mentioned above requires an academic certificate be connected to completion of five university courses. In order to build certificates that met university requirements and would be sustainable beyond the period of grant funding, program leaders used what they learned from university faculty and local employers about workforce development needs to expand course and certificate offerings that increase academic and career options for both traditional and non-traditional students. The success of this strategy bodes well for the long-term sustainability of the new certificates and is a foundation for development of additional new certificates in the coming years. While CEMS, and UVM in general, excel at supporting traditional students, the grant allowed CEMS to experiment with supports for non-traditional students, including a text book lending library, off-site tutoring, internship placement, and career counseling. Certificate participants raised the issue of advising, and suggest that even for degree seeking students, the traditional academic advising structure is no longer adequate. A new advising system that integrates academics and career pathways is one approach that could meet overlapping needs of traditional students and those in the TAACCCT target populations.

Building New Relationships

The idea of relationships is embedded in the name STEM-Connect. Grant funding empowered CEMS to reach out to local employers, the National and Air Guards, and organizations interested in a shared goal of building workforce development pathways. Formal and informal partnerships were formed with VDOL, Vermont HiTEC, Vermont Student Assistance Corporation, and several smaller service groups such as Vermont Works for Women and Vermont Refugee Resettlement. Some of these new relationships informed development of the certificate programs, and many were key to raising awareness in TAACCCT target populations about the new workforce preparation opportunities. CEMS also embarked on a multifaceted marketing campaign to raise awareness about the new certificates. Relationships across units within UVM were also enhanced, particularly with the Veterans Services office and with CDE. The latter case is particularly noteworthy, because in the grant the traditional roles of CDE and an academic unit

were reversed. Historically CDE created programming for non-degree students; in STEM-Connect the academic unit CEMS drove creation of new certificates and collaborated with CDE on their design, delivery, and marketing.

Planting Seeds

In a large academic institution where change is by design slow, there are indications that CEMS' efforts to develop new academic certificates, raise local awareness of the certificate programs, and build new relationships across UVM and with other organizations focused on workforce development are a strong foundation for building an agile approach to supporting workforce preparation. Within CEMS the grant has reinvigorated faculty who are now "academic champions" for current and future certificates. In order to implement STEM-Connect, CEMS had to learn from partners and participants, showing itself to be a true learning organization – and in the process is changing how partners and their clients think about UVM's accessibility. Across UVM more broadly, CEMS has become a model for using academic certificates to develop new programs and reach new audiences. Other colleges are now talking about developing their own certificates, and already marketing of some of their degree programs in ways similar to those used by CEMS through STEM-Connect.

Outcome Study Findings

Level 1: Outcomes for Participants

Findings

More than twice as many participants as expected enrolled in STEM-Connect Certificates (311).

However, approximately half of the expected number of participants completed their programs of study by the end of the program period (75), with nearly three-quarters of the enrollees still engaged in the program. Contributing factors for this lag mentioned in the implementation analysis include delays at the beginning of the project and the lengthy and rigorous certificate review process. Many of the 221 participants currently enrolled are poised to complete the program.

Undergraduates completing certificates tended to view the programs as providing a distinctive competitive advantage, including increased knowledge and skill development relevant to the job market. Those currently enrolled, either as non-degree students or graduate students additionally viewed the certificates as supporting career change, "right-sized" for those who were not seeking a degree, and useful for providing credentials for further education.

Descriptive Statistics:

The following tables and narrative provide a description of the outcomes for students enrolled in the STEM-Connect program. These data correspond to the nine designated outcome measures of the TAACCCT program.

Table 10: Expected vs Actual Outcome Measures Designated in the SGA

Outcome Measure	Expected	Actual
Total Unique Participants Enrolled*	150	311
Total Number of Participants Completing a TAACCCT-Funded Program of Study	135	75
Total Number of Participants Still Retained in Their Program of Study or Other TAACCCT-Funded Program	7	221
Total Number of Participants Earning Credit Hours	146	294
Total Number of Participants Earning Credentials	135	75
Total Number of Participants Enrolled in Further Education	24	0
Total Number of Participants Employed After TAACCCT-funded Program of Study Completion	116	10
Total Number of Participants Retained in Employment After Program of Study Completion	116	2
Total Number of Those Participants Employed at Enrollment Who Received a Wage Increase Post-Enrollment	15	48

Source: Program Administrative Records and VT DOL Employment data.

*Over the life of the program an additional 2,088 students who did not enroll in a certificate program took a TAACCCT-funded course as part of their regular University Program.

As indicated in Table 10, actual enrollment in STEM-Connect's certificate programs was more than double the enrollment expected (311 vs. 150). Most of this enrollment is accounted for by the perceived benefits of the certificate programs for traditional undergraduates.

At the same time, a little more than half the number of participants expected to complete the program did so (75 vs. 135). The implementation evaluation findings note a change in leadership at the beginning of the program. This caused some delay in the program's implementation. As of June 30, 2017, the end of the program period, 42 of the 221 participants still engaged in the program had only one course remaining to complete the certificate program in which they were enrolled. These 42 individuals may well be expected to complete the program within the first year following the funding period, bringing the total number of participants completing a TAACCCT-funded program of study to 117 after the first year.

The number of participants obtaining credit hours (294) is more than the 135 expected, and consistent with the total enrollment count of 311 for this credit-bearing program.

While no participants were counted as enrolled in further study (defined as study at other than the awardee institution), many of the participants are completing bachelor's degrees at the University of Vermont.

Actual employment related outcomes are lower than those expected, but no conclusions may be drawn from these results. As explained earlier in the sections describing the limitations of the study, employment data was obtained from VDOL, which did not have wage data on many participants. In the earlier description of participant characteristics it was noted that as primarily undergraduates, most participants, if working at all when they enrolled, reported working in part-time positions typical of undergraduates. The 75 participants who completed the program were all undergraduates. Of that number, 43 remain enrolled in a degree program and of the 32 that graduated, all but 2 graduated in May of 2017. Thus, it is too early to judge career earnings.

TABLE 11: Participant Count by Certificate

Certificate/Track	Enrolled Count	Percent	Earned Certificate	Percent
Pre-Actuarial	18	6%	1	1%
Computer Aided Engineering Design	10	3%	0	0%
Complex Systems	12	4%	2	1%
Cybersecurity	25	8%	5	3%
Computer Software (CS) - Master's Preparation	43	14%	31	17%
CS - Self Designed	4	1%	0	0%
CS - Software Development	71	23%	5	3%
CS - Web Development	128	41%	31	17%
Total	311		75	

Seventy-five of the 311 participants successfully completed their certificate programs. As shown in Table 11, no participants had completed the Computer Aided Engineering Design or CS-Self Designed Certificates during the program period. The Computer Aided Engineering Design Certificate was the last certificate up and running, completing the University's approval process in May of 2017. The CS-Self Designed Certificate serves a small niche of participants.

Participants' Perceptions of Program's Employment-Related Value

To further explore employment-related outcomes, the evaluation included a content analysis of interviews conducted with a sample of participants to assess participant perception of the program's actual or anticipated effect on employment and earnings.

Findings

Undergraduates completing certificates tended to view the programs as providing a distinctive competitive advantage, including increased knowledge and skill development relevant to the job market. Those currently enrolled, either as non-degree students or graduate students additionally viewed the certificates as supporting career change, "right-sized" for those who were not seeking a degree, and useful for providing credentials for further education.

Sample: The evaluators selected a sample of 78 participants for phone interviews from the population of the 227 participants identified by the program at the time the interview process began (February 2017). The sample of 78 participants (roughly 1/3) included those with the following characteristics:

- All 20 participants who withdrew from the program before completion at that point in time;
- All 27 participants who had completed the program; and,
- All 31 participants still actively engaged in the program who were not part of the typical university undergraduate population.

Respondents: Of the sample, 24 individuals agreed to be interviewed, 10 who had completed the program and 14 still actively enrolled. No individuals who withdrew agreed to be interviewed.

Process: The interview process began with an email communication from the Program Manager describing the interviews, their importance, and how those selected for interviews would be contacted. This communication also reminded the participants that they were provided information about their role in the program evaluation when they enrolled. This communication was followed by email communication from the interview team to introduce the process and set up appointments for the phone interviews. The interview team followed up twice with those who did not respond to the initial request.

Protocol: The phone interview protocol (See Appendix 4), solicited a qualitative assessment of the participants' experience in the program and of the program's actual or anticipated effect on employment and earnings.

Timeline: The first communication to interviewees was sent on February 17, 2017 and the final interview took place on May 3, 2017.

Results: Tables 12 and 13 below and on the following page describe the employment-related outcomes perceived by participants interviewed by the evaluation team.

Table 12: STEM-Connect Participant Interviews:
Certificate Completers' Perceived Employment Related Value

ID	Type	Traditional (T)/ Non-traditional (NT)	Certificate	Employment Status During Enrollment	Employment Status at Time of Interview	Perceived employment-related value					
						Distinctive competitive advantage	Content and Skills	Job market relevance	Supports career change	Right sized	Credential for further education
101	Undergraduate	T	CS-Web Development	Full -time student working part time	Undergraduate entering 2018 job market	X	X				
102	Undergraduate	T	CS-Web Development	student working part time	2017 graduate entering job market	X					
103	Undergraduate	T	CS-Web Development	Not employed	2017 graduate entering job market		X	X			
104	Undergraduate	T	CS-Web Development	Full -time student working part time	obtained post graduation position at $80,000 annual salary		X				
105	Undergraduate	T	CS-Web Development	Full -time student working part time	Undergraduate entering 2018 job market		X				
106	Undergraduate	T	CS-Web Development	Not employed	Undergraduate entering 2019 job market						
107	Undergraduate	N	CS-Web Development	No data	2017 graduate entering job market	X		X			
108	Undergraduate	T	CS-Masters Prep	Not employed	Undergraduate entering 2019 job market						
109	Undergraduate	T	CS-Web Development	student working part time	2017 graduate entering job market						
110	Undergraduate	NT	CS-Web Development	in Internship	employed, programming/						

Table 13: STEM-Connect Participant Interviews:
Current Participants' Perceived Employment Related Value

ID	Type	Traditional (T)/ Non-traditional (NT)	Certificate	Employment Status During Enrollment	Employment Status at Time of Interview	Perceived employment-related value					
						Distinctive competitive advantage	Content and Skills	Job market relevance	Supports career change	Right sized	Credential for further education
111	Graduate	T	Complex Systems	Part time research assistant	Working toward Ph.D.		X	X			
112	Undergraduate	T	CS-Software Development	Full -time student working part time	Current Undergraduate entering 2020 job market			X			
113	Non-degree	NT	CS-Web Development	Full time, technical services	Attained full-time employment as Web Developer	X	X				
114	Non-degree	NT	CS-Masters Prep	Full time, speech pathology	Still working in current position				X	X	
115	Graduate	NT	Complex Systems	Fellowship student	Working toward Ph.D.	X	X	X			
116	Non-degree	NT	Pre-Actuarial	Full time in health science field	Still working in current position		X		X		
117	Non-degree	NT	CS-Web Development	Full time technical suppport	Still working in current position		X			X	X
118	Non-degree	NT	CS-Software Development	Recently laid off	Unemployed						X
119	Non-degree	NT	CS-Software Development	Full time equipment technician	Still working in current position		X			X	X
120	Graduate	T	Complex Systems	Unemployed	Unemployed						
121	Non-degree	NT	Complex Systems	Full time IT professional	Still working in current position		X			X	
122	Graduate	T	Complex Systems	Part time graduate assistant	Part time graduate assistant		X	X			
123	Graduate	T	Complex Systems	Part time graduate assistant	Part time graduate assistant			X			
124	Non-degree	NT	CS-Web Development	Full time H.S. teacher	Plans uncertain						

Because all the participants who had completed a certificate series when the interviews were conducted were undergraduate students, several could not distinguish the job-related benefits of the certificate from those of their undergraduate major. Those that did articulate the certificate program's employment-related benefits specifically, however, believed that the certificate provided a distinctive competitive advantage, particularly in showing evidence of a unique skill that not everyone in their field would be able to demonstrate. They also mentioned its relevance to the job market they were entering. Many also mentioned the value it provided in learning new content and skills.

Interviews with participants still currently enrolled in the program focused on those who were part-time or non-degree students, or those older students in a graduate program. These students more closely reflect the target population for certificate programs that can be completed in two years or less. These participants articulated many employment-related benefits. In addition to the benefits of competitive advantage, job market relevance, and content and skills development mentioned by those who had completed certificates, these participants also spoke of the certificate programs as a valuable support for career change, being "right-sized," and providing a credential that would support the pursuit of further study.

For example, one participant, a non-degree student working full-time while enrolled in the CS-Web Development Certificate, who credits the certificate program as enabling his acquiring a new position as a web developer with a 20% wage increase, describes the distinctive advantage provided in this way.

> *"[I] think that [the certificate] can't be underestimated in terms of getting an employer to think twice about you not having a bachelor's degree in Computer Science… Overall I think the program is super useful, I would recommend it to someone else."*

A graduate student participant talked about skills and knowledge gained through the Complex Systems Certificate in this way:

> *"[I] like the fact that I come from very natural science background but I am able to get and apply these strong engineering and math type courses is something I haven't seen in any other school."*

Another described its relevance to the job market as follows:

> *"Data Science and Complex Systems' fields are very relevant to the job market. Many companies looking for people in these fields. The need is strong for those who can understand how to mine data. Courses align well with job market needs."*

A participant who described himself as someone without a bachelor's degree nor the background courses needed to matriculate, described the benefits of the CS-Software Development Certificate as the "right-sized" option for credentialing:

> *"Feels like I'm making up for something that I lack; wasn't exactly planning on taking the Certificate program, but once I figured out it was there, it kicked me into gear to actually move towards a Certificate. . . provides a pathway to credentialing – especially for someone that doesn't have a college experience."*

With only 24 of the 78 participants contacted agreeing to be interviewed (31%), there is no way of knowing whether those who responded are representative of all participants who completed certificates and of the non-degree and graduate students currently enrolled. Thus, the results of the interviews reflect only the self-report of those willing to be interviewed. It is possible the overall results would be different if the response rate had been 100%. Nonetheless, these results do provide examples of successful career outcomes and realized value for some participants. They offer insight into participants' perceptions and experiences in STEM-Connect's certificate programs that can serve as a starting point for continuing support and development after the funding period, particularly in terms of providing value for non-degree students seeking career changes or for whom a bachelor's degree is not a present option.

Level 2: Comparison of Participants and Non-Enrolled Samples

Comparison Groups

As indicated in Figure 9, the population for comparison consisted of 311 Participants and 2,088 non-enrolled students who took a STEM-Connect course as part of their regular University program.

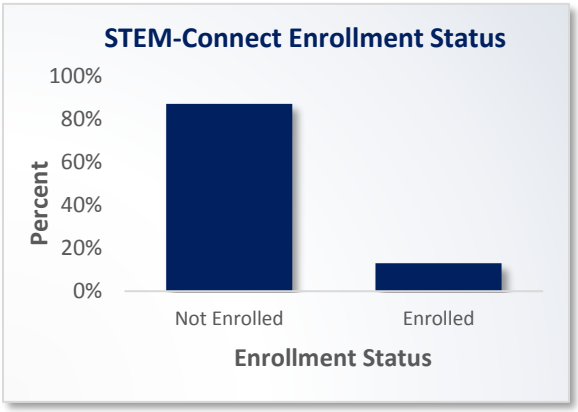

Figure 9: Comparisons groups

Comparison of Background Variables

Question 1*: To what extent are the participants and non-enrolled students (comparison group) different with respect to the background variables of gender, parents' level of education, age, and financial need?*

As indicated in Figures 10-13 below the percentage of difference between the participant and the non-enrolled samples were relatively small and not significant in any of the chi-square analyses performed on the data. See Appendix 5 for accompanying tables.

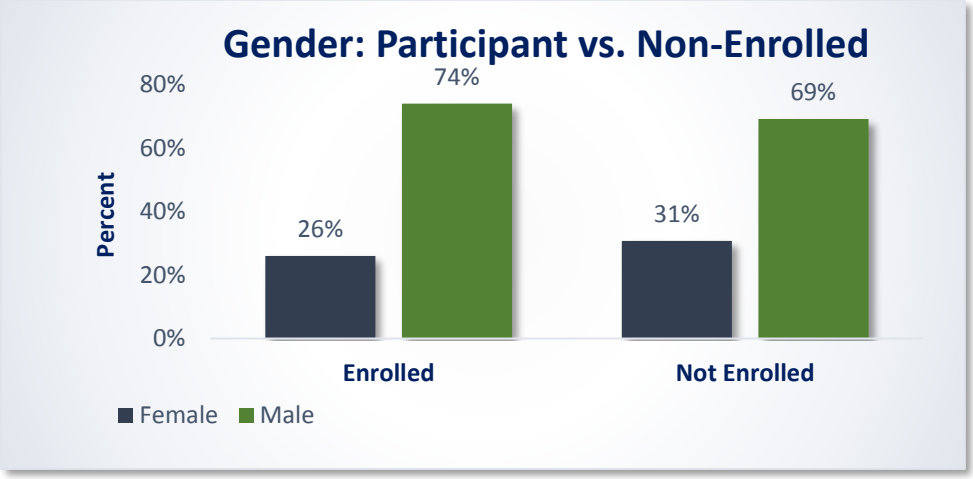

Figure 10: Comparison groups gender distribution

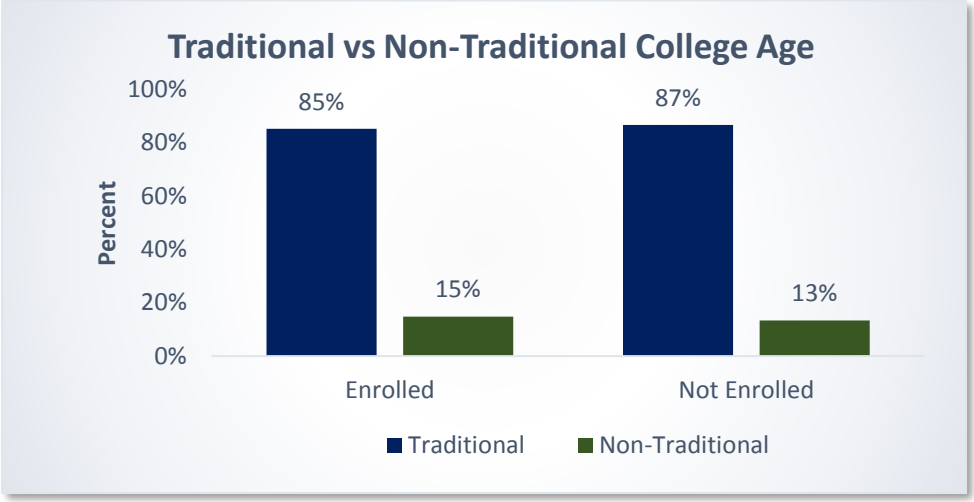

Figure 11: Comparison groups traditional/non-traditional college age distribution

Dichotomy was split (by age in years, T = Traditional, N = Non-traditional) as follows: T <= 24 < N

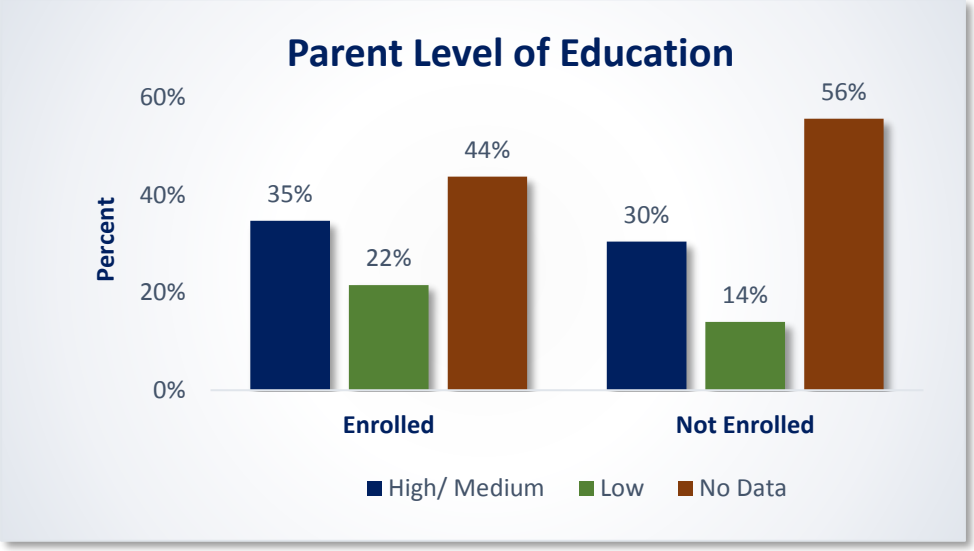

Figure 12: Comparison Groups level of parent education distribution

Data were summarized in order to protect the identity of participants in small cell sizes (11 or fewer). Categories originally coded as ranks of parent education from less than high school to graduate degrees were collapsed as follows. High/medium = some college or beyond; Low=middle/jr high, high school; no data.

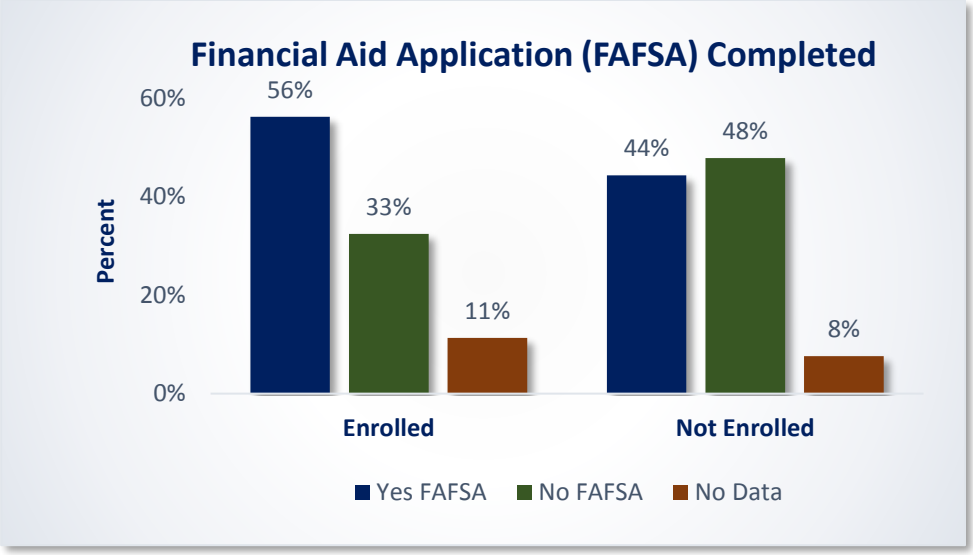

Figure 13: Comparison groups financial need distribution

Estimate of Financial Need was determined by whether or not the individual had completed a Free Application for Federal Student Aid (FAFSA) Application.

Wage Comparisons

Question 2: *To what extent does the STEM-Connect program result in higher wages being earned by participants relative to the comparison group?*

It is evident from Figure 14 below that the non-enrolled students out-performed the participant group. Since the demographic variables, above are not statistically different among the groups studied there is no opportunity to explain the difference in wages on that basis. The direction of gender differences and financial aid eligibility are consistent with larger demographic trends, e.g. females and lower income students tend to obtain less desirable employment outcomes.

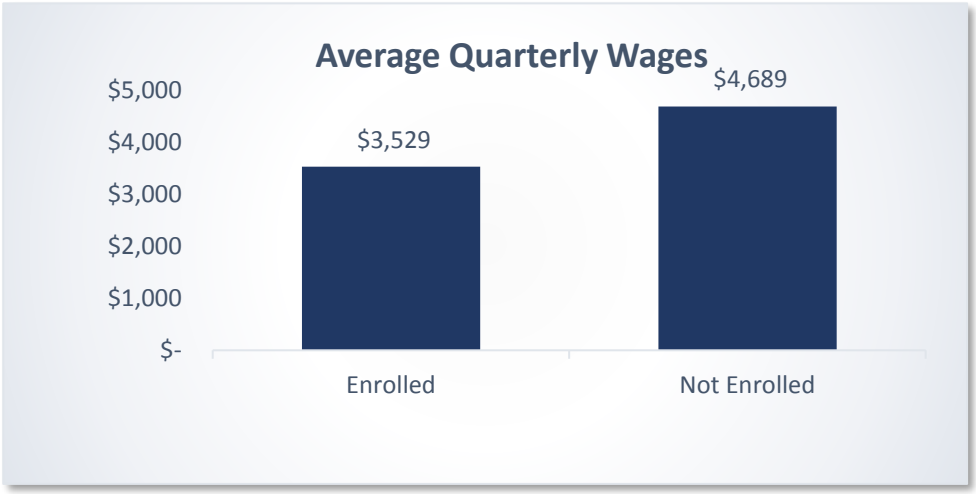

Figure 14: Average quarterly wages for participants and non-enrolled

Rates of Employment

Question 3: *To what extent does the STEM Connect program result in higher rates of employment relative to the comparison group?*

As Figure 15 below indicates, there is essentially no difference in the proportion of individuals in either group employed at the time the data were obtained. Since the population is a traditional student age and not representative of the adult population which would tend to be in the labor market, this outcome is not surprising.

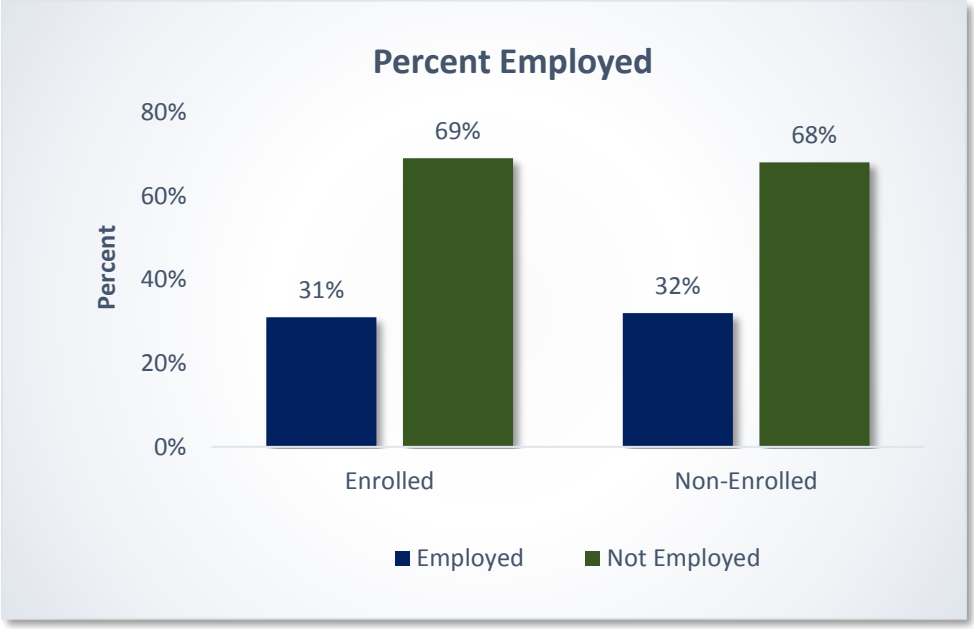

Figure 15: Percent employed for participants and non-enrolled

The chi-square statistic is 0.1438. The *p*-value is .704501. This result is *not* significant at $p < .05$.

Academic Achievement

Question 4: *To what extent does the STEM Connect program result in higher Grade Point Averages (GPAs) relative to the comparison group?*

Response: As Figure 16 below indicates, there is a significant difference between the participant and non-enrolled groups which favors the participant group. Participants are 10 percent more likely to have High to Mid-Range GPA's and 10 percent less likely to have low GPAs than their non-enrolled peers.

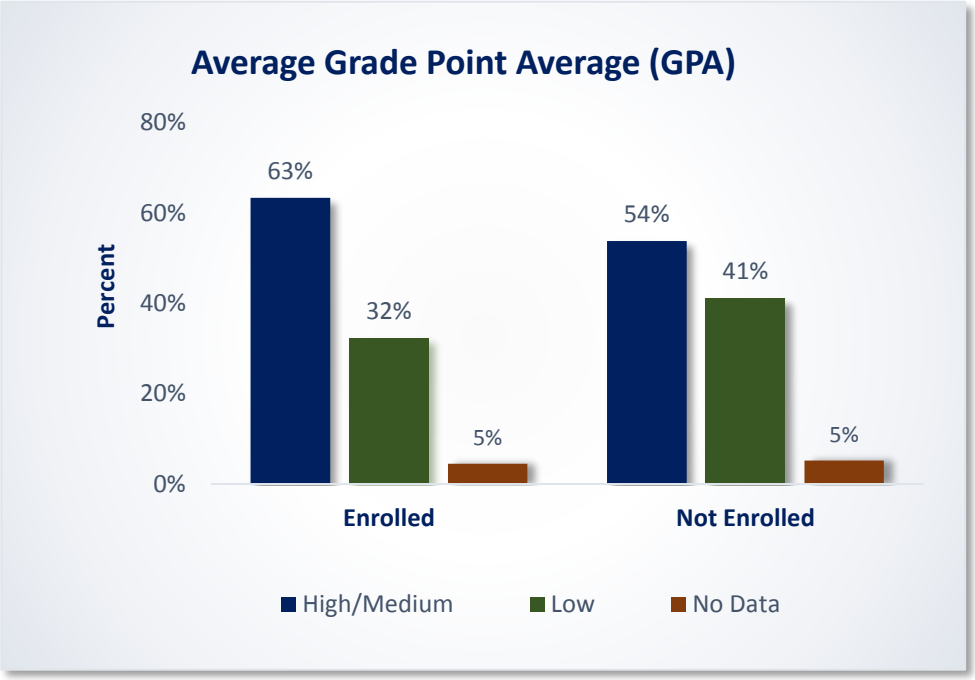

Figure 16: Mean grade point average for participants and non-enrolled

GPA: an arithmetic mean of 2.87 was calculated for the GPA (from unique participant records). The student GPA value used for each student was the most recent available (at the time of most recent course within a TAACCCT certificate was taken). GPA was split into two groups (L = Low, HM = High-Medium) by the mean as follows: L< 2.87 <= HM

Discussion of Level 2 Findings

Quantitative analysis of program outcomes reflect a generalized picture that is heavily influenced by the limitations of both the program design and the characteristics of the data with respect to the outcomes of individual participants. That is, recruitment of students began mid-way through the second year of the program at the University. As described earlier the University is a predominantly undergraduate institution attracting a traditional student-aged population. While it was a primary goal of the grant program to build the capacity of the institution to develop coursework, systems and supports to serve an adult, non-traditional aged population, the development of the program must of necessity precede the recruitment of participants. Although the TAACCCT goals and specified outcomes are increased wage levels and employment, it was unlikely that large numbers of graduates would enter the workforce by program's end. Thus, estimates of targets for participants and non-enrolled students and any comparisons between participant and non-enrolled groups were subject to the same limitations on opportunities to become employed. In particular, students could (and did) complete certificates (n=75) in the last year in numbers that nearly met that year's target without the opportunity (because they are for the most part still undergraduates) to enter the workforce.

One set of relationships that emerged from the data concerned the relationship between financial aid and the program outcomes of participants either remaining active status, completing the

certificate, or withdrawing from the program. Here it seems that financial aid was both a driver to success and a source of failure when absent.

In addition, as discussed in the section on Limitations (above) there were certain limitations that have constrained the study of outcomes and relationships among student characteristics. Chief among these limitations was the failure to complete the student questionnaire which was the source of variables such as the student background characteristics and certain outcomes. Fifty-seven percent of the population of participants completed the online survey. The non-enrolled students did not complete the survey. Comparisons between participants and non-enrolled students were limited to only those variables contained in the University's general student data base and the VDOL data base.

Conclusion

Key Lessons Learned

Different Institutional Contexts require Different Approaches to Implementation

One key lesson stems from the first two themes that emerged from the implementation analysis, *University Setting* and *Weaving New Academic Certificates and New Student Populations into the Fabric of UVM*. In a primarily undergraduate research university whose stated mission is not directly aligned with typical strategies employed by other TAACCCT grantees for adult, displaced workers, the program required a different approach. Its approach, to create certificates that had something to offer to both populations, heightened benefits for both. Non-degree students earn certificates that offer advanced skills and academic recognition, as well as career paths and assist them in finding internship opportunities. Traditional undergraduates earn a credential that will offer a distinctive advantage not seen by other undergraduates and gain assistance with finding internships and increased interdisciplinary interactions.

Program Benefits Emerge over Time

A second key lesson stems from the third and fourth themes, *Building New Relationships* and *Planting Seeds*. It is important to recognize the significant time required to implement a new program like STEM-Connect. New relationships often require a long time for meaningful collaboration to emerge, particularly when trying to reach new audiences and change perceptions. Universities are often perceived as preparing students for jobs that don't yet exist. It will take a while for the program benefits to fully surface and flourish and it is important to recognize the value of planting seeds and creating a strong and meaningful foundation.

UVM Can Serve a Unique Workforce Development Niche

- For workforce development, UVM is better positioned to prepare individuals for entry into higher levels of employment, and help those who need to update or hone existing job skills. It is not well positioned to support those who are not prepared for rigorous academics. The career maps accompanying the certificate descriptions in Appendix 2 illustrate a need for workforce development at the level that STEM-Connect provides.
- Combined, the new certificates, new courses which incorporate more engaging instructional approaches, new relationships with those focused on workforce development, and new approaches to marketing are evidence of UVM CEMS' increased capacity and newfound commitment to serving needs in the local community and beyond.
- Challenges remain, however. Undergraduate admission to UVM is quite competitive, and as a result the University is not yet well positioned to support those who are not prepared for rigorous academics. As CEMS seeks to enroll non-traditional students, especially those in the TAACCCT target population who may have little experience with higher education or have been out of school for many years, it may be necessary to further enhance its student support systems.

Barriers for Non-Traditional Students are Substantial

- The cost of tuition is a significant barrier to participation in this program. Grant funds were not allowed for direct participant support, and other funding depends on fitting neatly into specific categories (Post 911 GI Bill, for example).
- UVM is not always perceived as a friendly campus for non-traditional students. While this is not fully understood, possible reasons include unfamiliarity with bureaucratic processes or online course platforms, lack of academic preparation, or time constraints.
- There are unique challenges for serving the veteran and National Guard populations. Guard members are deployable and hesitant to commit to this type of program. Because funding generally doesn't cover all the costs it can seem financially risky for them.
- CEMS's certificate programs do not meet all needs. Those who work directly with the unemployed report that many recently unemployed individuals are looking for short-term training and immediate employment.

Implications for Future Research

Future research suggested by the STEM-Connect experiment in building institutional capacity and creating partnerships at the university level should involve the interpretation of Department of Labor-specified participant outcomes on a time scale appropriate for the four-year degree. Lengthening the expected time period from three to six years would place the evaluation on a time scale appropriate to graduates' ability to enter the job market. Likewise, the measure of wage/salary outcomes should reflect the time period for market entry that is realistic for the four-year student enrollment.

Institutional change study designs (implementation) should engage four-year institutions in identifying what changes the institutions are committed to making and articulate the

evaluation/research design on a time frame appropriate to the pace of change which is normal and reasonable for four-year institutions. In other words, for the Department of Labor or similar sponsors to facilitate growth and change in university contributions to the economy through workforce development, then solicitation offerings should accommodate a time scale and institutional change strategy that fits the context of university development.

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