Evaluation of Austin Community College Bio-Link Regional Advanced Technological Education Center for Biotechnology and Life Sciences:

2016-2017 Grant Activities

August 2017

Submitted by:

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BY: CANDIYA MANN & YI JEN WANG

SOCIAL & ECONOMIC SCIENCES RESEARCH CENTER, PUGET SOUND OFFICE

WASHINGTON STATE UNIVERSITY

AUGUST 2017

In September 2015, the National Science Foundation NSF funded the Austin Community College Bio-Link Regional Advanced Technological Education Center for Biotechnology and Life Sciences (AC2). The AC2 Regional Center shares a mission with the Bio-Link National Center to "(1) increase the number and diversity of well-trained technicians in the workforce; (2) meet the ever-growing needs of a continually evolving and diversifying industry for appropriately trained technicians; and (3) institutionalize community college education practices that make high-quality education and training in the concepts, tools, skills processes, regulatory structure, and ethics of biotechnology available to all students." The AC2 Center focuses on the states of Texas and Kentucky, two states with high biotechnology industry growth.

The evaluation is based on multiple data sources, primarily surveys and interviews, and reflects the input of a variety of stakeholders, high school, two-year college, and four-year college and university educators and administrators; contract service organization representatives; representatives of government and industry; and AC2 management. This report covers grant activities that took place between September 1, 2016 and July 31, 2017.

Findings

Project Goal 1: Establish a sustainable, replicable Biotechnology Community College Distributed Leadership Network in each state to establish collaboration across educational and industry systems.

In 2016-2017, the AC2 Community of Practice (CoP) made substantial progress, conducting a needs assessment of the community, determining the CoP structure and features, and researching the options for an online communications hub. In 2017-2018, the CoP will launch the communications hub, hold a membership drive, and prepare a mini-case study about the roll-out of the Contract Service Organization (CSO) CoP, which will be the first CoP topic. Project

Goal 2: Scale-up the Biotechnology High School/College Mentor Network originated in Texas to support high school teachers to implement industry appropriate life science courses.

The Teacher Mentor Network in Texas was very active:

- The Network consisted of 31 teachers at 31 schools, 15 of which joined the network in 2016-2017. Seven of the 15 will start new courses in Fall 2017, due, at least in part, to their involvement in the Network.
- Four master teachers from the Network mentored other teachers in their area of the state in 2016-2017.
- Seven high schools offered biotechnology courses for the first time in 2016-2017, with an estimated 200 students attending.
- The High School Teacher Workshop was held June 12-16, 2017, in Austin, Texas, with 14 participants. In the post-workshop survey (response rate: 93%), all of the respondents (100%) rated the workshop as excellent and indicated that they would recommend the workshop to their colleagues. Respondents improved their knowledge and comfort in all biotechnology concepts included in the survey.

The Teacher Mentor Network in Kentucky made great strides:

- Three teachers in three high schools were mentored.
- The Network researched the status of where biotechnology is located within pre-existing pathways and developed a pilot pathway within the STEM career cluster.
- The first course of the pathway will be offered in 2016-2017 at one high school, and two other high schools with incorporate biotechnology modules, activities, and/or research

Project Goal 3: Develop new student recruitment pipelines into the industry that include using undergraduate research as a hook in feeder courses to attract and retain students interested in life science careers.

All of the partner colleges have incorporated undergraduate research into their courses, with a variety of crowdsourced and locally-based projects. Students have presented their research at a multiple conferences and meetings (where they have won awards) and have published in peer-reviewed journals.

On April 21-22, 2017, Del Mar College hosted the AC2 Bio-Link Research Mentoring Workshop, where students presented posters on the first day and 14 faculty learned best practices for implementing undergraduate research on the second day. In the post-workshop survey (response rate: 93%), 75% of the respondents rated the usefulness of the workshop as excellent, and 25% rated it as good. All respondents agreed that the workshop updated their knowledge, and all but one plan to implement something they learned.

Data collected by AC2 partner colleges indicate that undergraduate research may encourage students to enroll in biotechnology programs. Recruitment of students in undergraduate research experience ranged from 9%-83%.

Project Goal 4: Implement an entry-level certificate in high schools and community colleges to facilitate entry into bio-technician jobs in industry.

In 2016-2017, six students in Texas completed the certificate, and one was hired at a biotechnology incubator. In 2017-2018, the full certificate will be in place in the high schools, with all courses active. In Kentucky, the first course of the certificate will be piloted in 2017-2018.

Project Goal 5: Establish Educational Contract Research Organizations (CSOs) pairing industry projects with student internships and faculty externships to benefit companies, students, and faculty.

Texas update: The ACC Bioscience Incubator (ABI) opened in February 2017. It currently hosts seven companies. Since opening its doors, ABI has generated six full-time positions, three part-time positions, and one contractor position. Companies have hosted six interns and one faculty extern. The incubator has produced a variety of educational benefits beyond the internships and externships, including curricula development and hosting student training sessions. In two case studies, ABI contributed to savings of both money and time to bring products to market; the first company saved $156,000 and two months off the expected time to market, and the second company saved $230,000 and two to three months.

Kentucky update: BCTC is in the process of developing a CSO, named the Bioscience Collaborative Educational Learning Laboratory (B-CELL). B-CELL is currently under construction, slated to open in spring 2018. In 2016-2017, BCTC worked intensively to develop the infrastructure necessary to support B-CELL. Through the auspices of completing the *CSO Baseline Report*, which details the CSOs and incubators in community colleges around the country, BCTC created relationships and formal partnerships with other CSOs. B-CELL purchased its first major piece of equipment and made progress in developing the CSO Toolkit (sample documentation for two-year colleges beginning CSOs) and the CSO Consortium (where CSOs can join together to share equipment and resources.)

CSO Summit: On April 7-8, 2017, BCTC led the AC2 CSO Summit in Austin, Texas. The summit brought together representatives of CSOs and incubators from across the country, in addition to representatives of government and industry. In the post-Summit survey (response rate: 32% of 38 attendees), 92% of the respondents rated the Summit as excellent and 8% as good. All of the respondents indicated that the event helped them update their skills and knowledge, and 89% plan to implement something they learned. Twelve attendees plan to share the information from the Summit with 270 colleagues, and four attendees plan to share the information with 94

students. Attendees made an average of 12 new contacts apiece, and they plan to contact an average of nine contacts apiece after the event to develop working relationships.

Project Goal 6: Establish universal (statewide) articulation and reverse articulation among educational partners to facilitate academic transferability and increase degree completion.

The main focus for Goal Six in 2016-2017 was saving the academic status of two foundational courses, BIOL 1414 and 1415; the academic status allows the courses to transfer as biology courses for majors, an important condition necessary to develop articulation agreements. This effort was ultimately successful.

In 2016-2017, AC2 had developed articulation agreements between community colleges and Texas A&M-Texarkana and Texas A&M-Corpus Christi. Agreements are in progress with Texas A&M-Central. Meetings have been held to discuss articulation with the University of North Texas, Texas Tech University, and Texas State University.

In addition, the Texas Teacher Mentor Network has coordinated articulation agreements between 11 high schools and ACC. In 2016-2017, a total of 292 students used these agreements. (Note that this is not a goal for BCTC since the Council on Postsecondary Education requires all courses to transfer between colleges and universities.)

Conclusions

Overall, the evaluation finds that the AC2 Center has successfully implemented the second year of its grant, making progress on all six grant goals. The initiatives, which have undergone significant development in 2016-2017, are starting to bear fruit in student access to biotechnology courses in high school and to undergraduate research in college. The AC2 Center has effectively brought together the biotechnology community through multiple events. In sum, 2016-2017 has been a very productive year for the AC2 Bio-Link Regional Center in its progress towards meeting its mission of increasing the number and diversity of well-trained technicians in the workforce, meeting the needs of this quickly evolving industry, and institutionalizing high quality practices in biotechnology education.

INTRODUCTION

In September 2015, the National Science Foundation NSF funded the Austin Community College Bio-Link Regional Advanced Technological Education Center for Biotechnology and Life Sciences (AC2). The AC2 Regional Center shares a mission with the Bio-Link National Center to "(1) increase the number and diversity of well-trained technicians in the workforce; (2) meet the ever-growing needs of a continually evolving and diversifying industry for appropriately trained technicians; and (3) institutionalize community college education practices that make high-quality education and training in the concepts, tools, skills processes, regulatory structure, and ethics of biotechnology available to all students." The AC2 Center focuses on the states of Texas and Kentucky, two states with high biotechnology industry growth.

As stated in the proposal, the AC2 Center has six goals:

1) Establish a sustainable, replicable Biotechnology Community College Distributed Leadership Network in each state to establish collaboration across educational and industry systems
2) Scale-up the Biotechnology High School/College Mentor Network to support high school teachers to implement industry appropriate life science courses
3) Develop new student recruitment pipelines into the industry that include using undergraduate research as a hook in feeder courses and programs to attract and retain students in life science careers
4) Implement an entry-level certificate in high schools and community colleges to facilitate entry into bio-technician jobs in industry
5) Establish Contract Service Organizations (CSO) in community colleges pairing industry projects with student internships and faculty externships to benefit companies, students, and faculty
6) Establish statewide articulation and reversed articulation agreements among educational partners to facilitate academic transferability and increase degree completion

This report covers grant activities that took place between August 1, 2016 and July 31, 2017. The AC2 Center grant evaluation was performed by the Puget Sound Division of the Social and Economic Sciences Research Center at Washington State University.

Evaluation Questions

The evaluation connects each of the project goals with evaluation questions and expected outcomes of the project. These goals and evaluation questions are presented below.

Table 1: Project Strategies and Evaluation Questions

Project Goal	Evaluation Questions
Goal 1. Establish a sustainable, replicable Biotechnology Community College Distributed Leadership Network in each state to establish collaboration across educational and industry systems	
1a. Set Up Circles to establish Communities of Practice (CoPs) and develop attributes of the network 1b. Develop interactive web portal for center and statewide Bio-Link networks	1.1. Do the CoPs function as a venue to bring together government, education, and industry for direct communication and collaboration to ensure that biotechnology education across the region focuses on best practices and meeting the industry's needs? (There is currently no venue for direct communication between these stakeholders.) 1.2. Do the CoPs meet regularly, develop plans of action to achieve the other five Center goals, make progress on their plans, and, over time, persist as part of a sustainable network? 1.3. Is a high functioning web portal developed that facilitates communication and collaboration?
Goal 2. Scale-up the Biotechnology High School/College Mentor Network originated in Texas to support high school teachers to implement industry appropriate life science courses:	
2a. Implement circle and CoP associated with Mentor Networks 2b. Pilot high school mentoring systems	2.1. How many high schools and districts offer new biotechnology courses due to the support from the Mentor Network? How many teachers are mentored, and how many go on to mentor other teachers? To what extent do the teachers feel supported? 2.2. How many students participate in the new biotechnology courses? To what extent does their performance improve between the placement test prior to the course and the exit exam at the close of the course?

Goal 3. Develop new student recruitment pipelines into the industry that include using undergraduate research as a hook in feeder courses to attract and retain students interested in life science careers	
3a. Identify best practices in student recruitment methods 3b. Market college Biotechnology certificate programs in high schools 3c. Develop marketing materials and strategies 3d. Support High School Career Day events	3.1. What best practices does the Circle identify in biotechnology student recruitment? To what extent are the best practices implemented? 3.2. Which aspects of a biotechnology program do students identify as being the most compelling in their decision to enroll? 3.3. How do the efforts (activities 3b, 3c, 3d) affect recruitment and retention in high school and college biotechnology courses and programs?
Goal 4. Implement an entry-level certificate in high schools and community colleges to facilitate entry into bio-technician jobs in industry	
4a. Develop Entry Level Biotechnology Certificate 4b. Scaffold Educate Teachers and Obtain equipment, and supplies 4c. Pilot certification exam for certifying entry level 4d. Expand Teacher Certification Program	4.1. How many students complete the Certificate (and/or certification exam) and enter biotechnology employment in the region? What are their career trajectories after employment? How do employers rate the readiness of these certificate holders? 4.2. How many teachers earn the teacher certification? To what extent does the certification prepare the teachers to deliver the Entry Level Biotechnology Certificate?
Goal 5. Establish Educational Contract Research Organizations pairing industry projects with student internships and faculty externships to benefit companies, students, and faculty	
5a. Deepen Ties with Industry 5b. Develop CSO course	5.1. How do the CSOs benefit the regional economy by supporting biotechnology start-ups, in terms of dollar savings, accelerating time to market, and encouraging biotechnology companies to stay in the region? 5.2. How do the CSO and the CSO course affect student and faculty understanding of biotechnology careers and job trends, and the students' readiness for biotechnology employment? 5.3 How well does the CSO course prepare students and faculty to work on industry-based projects?

Goal 6. Establish universal (statewide) articulation and reverse articulation among educational partners to facilitate academic transferability and increase degree completion	
6a. Form high school to community college universal articulation agreements 6b. Gain common core credit courses 6c.Develop articulation agreements among 2 and 4 year colleges 6d. Develop articulation and a reverse articulation pathway	6.1. To what extent do the Center's efforts under Goal 6 facilitate credit accumulation and transfer, enhancing the student pipeline from high school through to the university level, including reverse articulation? 6.2. How many students take advantage of the new articulation agreements and the common core courses? How have the articulation agreements affected the time-to-degree and the number of students completing biotechnology programs?

Data Sources

The evaluation relies upon multiple sources of data. The data collection includes input from a variety of stakeholders, including high school, two-year college, and four-year college and university educators and administrators; contract service organization representatives; representatives of government and industry; and AC2 management. Below are descriptions of each of the data sources. All of the surveys were developed in collaboration with the AC2 PI and co-PIs.

CSO SUMMIT SURVEY

On April 7-8, 2017, AC2 and Bio-Link sponsored the CSO Summit, which brought together representatives from CSOs and incubators across the country, in addition to representatives of governmental agencies, two-and four-year colleges and universities, and private companies. After the workshop, a web survey was circulated to the Summit participants. The survey collected the participants' ratings of the usefulness of the event, whether they gained knowledge at the event and what they learned, whether they plan to implement anything they learned at the Summit and what they plan to implement, whether they plan to share the information from the event with students or colleagues and how many, and suggestions for improvement of future CSO Summits.

AC2 RESEARCH MENTORING WORKSHOP

On April 21-22, 2017, Del Mar College hosted the AC2 Research Mentoring Workshop. Students presented posters on the first day, and educators learned best practices for implementing undergraduate research on the second day. After the workshop, a web survey was conducted of workshop participants. The survey collected participants' ratings of the usefulness of the event, whether they gained knowledge at the workshop and what they learned, whether they plan to implement anything they learned at the workshop and what they plan to implement, whether they plan to share

the information from the workshop with students or colleagues and how many, and suggestions for improvement of future Research Mentoring Workshops.

HIGH SCHOOL TEACHER SUMMER WORKSHOP POST-SURVEY

On June 12-16, 2017, AC2 held a High School Teacher Summer Workshop. The goals of the workshop were to introduce teachers to the online curriculum and provide hands-on experience in biotechnology skills. After the workshop, a web survey was conducted of participants. The survey collected information on the participants' ratings of the usefulness of the workshop, the most valuable aspect of the workshop, how the workshop could be improved, assessments of their knowledge and comfort with biotechnology skills and concepts before and after the workshop, plans for the next year, and logistical preferences for Mentor Network meetings and support in 2017-2018.

AC2 HIGH SCHOOL TEACHER MENTOR NETWORK SURVEY

On July 31, 2017, a survey was launched of the 14 Mentor Network members who attended the 2017 High School Teacher Workshop. The survey asks members about the impact of the Network on their confidence, knowledge, and teaching. It solicits members' feedback on the aspects of the Network they enjoy most, which aspects have impacted their courses, additional support and resources they need from the Network, and how likely they are to take on a mentor role in the Network.

ADDITIONAL DATA SOURCES

In addition to the surveys that the evaluation took the lead in developing, two surveys were developed where co-PI's took the lead, and the evaluator provided input on the survey design. These included the Community of Practice (CoP) Needs Assessment, and the survey of high school teachers conducted at the Kentucky Science Teachers Association. Questions from the CoP Needs Assessment were added to the end of the CSO Summit survey and the AC2 Research Mentoring Workshop survey. The evaluation also includes the results of a survey conducted of students in undergraduate research experiences at Collin College.

Furthermore, the evaluation relied on document review, including a variety of reports produced by the co-PIs, including the ACC Bioscience Commercialization Report, 2016-Q2; the CSO Baseline Report; Growing an AC2 Community of Practice, and end-of-year reports and logic model updates provided by the PI and co-PIs for each of the goals.

FINDINGS

Project Goal 1: Establish a sustainable, replicable Biotechnology Community College Distributed Leadership Network in each state to establish collaboration across educational and industry systems

Evaluation Questions:

1.1. Do the Communities of Practice (CoPs) function as a venue to bring together government, education, and industry for direct communication and collaboration to ensure that biotechnology education across the region focuses on best practices and meeting the industry's needs? (There is currently no venue for direct communication between these stakeholders.)

1.2. Do the CoPs meet regularly, develop plans of action to achieve the other five Center goals, make progress on their plans, and, over time, persist as part of a sustainable network?

1.3. Is a high functioning web portal developed that facilitates communication and collaboration?

In year two, there were three main objectives in support of goal one:

1) design the Communities of Practice (CoP) overall structure and features,
2) train the CoP moderators, and
3) launch the CoP communication hub.

Objective One: In order to accomplish the first objective, a needs assessment was conducted. Community input was solicited through a national survey (January-February 2017), a workshop at the Contract Service Organization (CSO) Summit (April 2017), and a session at the Bio-Link Summer Fellows Forum (June 2017). Community feedback was consistent across the data sources. Community members would like to connect both face-to-face and online. They would like to share knowledge, advice, resources, and teaching materials. (See "Growing an AC2 COP" for full survey results.) In response to the needs assessment findings, the COP Core Team decided to structure the COP as a single online communications hub with separate areas for each subject matter COP: CSOs, High School Mentoring, Articulations, and Bio-Link's Bridge to Bioscience Programs. With the intense community focus and

momentum behind CSOs at the CSO Summit and Summer Fellows Forum, in June 2017 the Core Team decided to focus on launching the CSO CoP first.

Objective Two: The CoP Core Team consists of the leads for all four CoP subject areas: CSOs, High School Mentoring, Articulations, and Bio-Link's Bridge to Bioscience Programs. The Core Team met 10 times between March and July of 2017. At these meetings, the CoP co-PI, Mary Slowinski, provided training in CoP leadership skills, and the team worked together to determine the goals for each COP, the technology needs, and strategies to connect members. The team will continue to meet and develop the CoP in year three.

Objective Three: The Core Team explored many options for an online communications hub in year two. Because some of the recommendations that came out of the needs assessment mirrored technological efforts that had already been attempted unsuccessfully in the past, there was some reluctance to invest in similar efforts again. In year three, the Core Team will endeavor to clarify the technology needs, select a technological solution, and implement it.

Goals for Year Three: In the next year, the CoP will develop and launch the communications hub, conduct a CoP membership drive, and prepare a mini-case study about launching the CSO CoP.

In sum: The CoP has made substantial progress in year two, conducting a needs assessment and meeting regularly to make progress towards the CoP launch. It is too early to assess the CoP evaluation questions.

Project Goal 2: Scale-up the Biotechnology High School/College Mentor Network originated in Texas to support high school teachers to implement industry appropriate life science courses.

Evaluation Questions:

2.1. How many high schools and districts offer new biotechnology courses due to the support from the Mentor Network? How many teachers are mentored, and how many go on to mentor other teachers? To what extent do the teachers feel supported?

2.2. How many students participate in the new biotechnology courses? To what extent does their performance improve between the placement test prior to the course and the exit exam at the close of the course?

The AC2 Bio-Link Regional Center covers both Texas and Kentucky. Since their teacher mentor networks are separate, they will be discussed separately here.

TEXAS TEACHER MENTOR NETWORK

In 2016-2017, the Teacher Mentor Network in Texas consisted of 31 teachers at 31 schools, 15 of which joined the network in 2016-2017. Of the 15 new schools, seven will be starting new courses in Fall 2017, at least in part due to the support they received through their participation in the Mentor Network. Eleven (11) of the Mentor Network schools are Title One, with high numbers or percentages of low-income students.

In 2016-2017, four master teachers from the Network mentored other teachers in their areas. (The state was divided into four regions, and each teacher was assigned to a region.) In 2017-2018, there will be six master teachers mentoring other teachers in six regions.

In 2016-2017, seven high schools in the mentor network offered a biotechnology course for the first time. Exact counts of students are not available, but the Mentor Network lead, co-PI Jennifer Lazare, estimates that over 200 students attended these courses (assuming 25 students per course, some courses with multiple sections).

In 2016-2017, nine students from the biotechnology programs at Anderson High School, LASA High School, and Lanier High School graduated and went on to enroll in the biotechnology program at Austin Community College.

The AC2 Bio-Link High School Teacher Workshop was held in Austin, Texas, on June 12-16, 2017. The goals of the workshop were to introduce teachers to the online curriculum and provide hands-on experience in biotechnology skills. In 2017, the workshop offered two tracks: with separate offerings for teachers who were novice versus experienced in teaching biotechnology.

Of the 14 teachers who attended the workshop, 13 completed the post-workshop survey (Response rate: 93%). All (100%) of the survey respondents rated the workshop as excellent. They reported that the most valuable aspects of the workshop were learning how to make the labs into successful learning experiences, collaborating with other teachers, gaining access to the curricula and other resources, and the opportunity for hands-on troubleshooting. One teacher explained the most valuable aspects as follows: "There were several: first - using the equipment. I will be teaching Biotechnology this coming school year. I was unfamiliar with proper use of most of the equipment my students will be using. Second: Learning from more experienced teachers as to what works and what doesn't in a classroom for biotechnology and how they ran their classes." Suggestions for improving the workshop included giving more background on the labs beforehand and providing more time and space for meeting as a group.

All (100%) of the respondents strongly agreed that the workshop clearly addressed the topics they wanted to learn; they would recommend the workshop to their colleagues; and the workshop addressed their concerns about teaching biotechnology techniques, concepts, and career information. The teachers reported large gains in their knowledge and comfort with the material in the following areas: (See Figure 1, Figure 2, and Figure 3)

- Sources of postsecondary biotechnology programs (e.g., ACC): Pre: 15% Excellent, Post: 67% Excellent
- Pathways of biotech courses (e.g., CTE courses, sequence of courses, articulations): Pre: 0% Excellent, Post: 92% Excellent
- Biotech industry and employment opportunities in their local area: Pre: 0% Excellent, Post: 50% Excellent
- Basic lab techniques (e.g., using a micropipette): Pre: 38% Excellent, Post: 83% Excellent
- Troubleshooting basic techniques: Pre: 15% Excellent, Post: 50% Excellent
- Biotechnology conceptual knowledge (e.g., How molecules move through agarose): Pre: 23% Excellent, Post: 50% Excellent
- Biotechnology current events/real world applications: Pre: 15% Excellent, Post: 58% Excellent
- Researching biotech career information: Pre: 31% Very Comfortable, Post: 75% Very Comfortable
- Teaching biotech techniques and concepts to your students: Pre: 15% Very Comfortable, Post: 58% Very Comfortable
- How to run your class like a company (soft skills, lab prep, QA): Pre: 0% Very Comfortable, Post: 58% Very Comfortable
- Lab kit preparations and ordering: Pre: 15% Very Comfortable, Post: 83% Very Comfortable

- Accessing biotechnology curriculum, resources, and standards: Pre: 15% Very Comfortable, Post: 75% Very Comfortable

Figure 1: AC2 High School Teacher Workshop: Pre-Post Knowledge

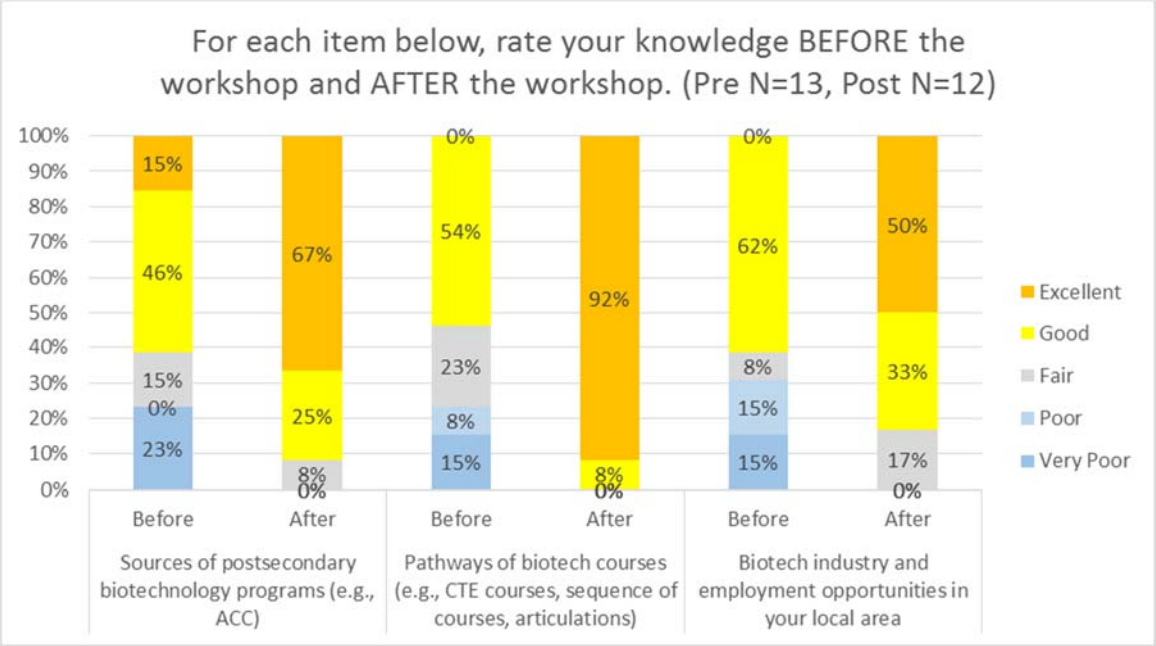


Figure 2: AC2 High School Teacher Workshop: Pre-Post Knowledge

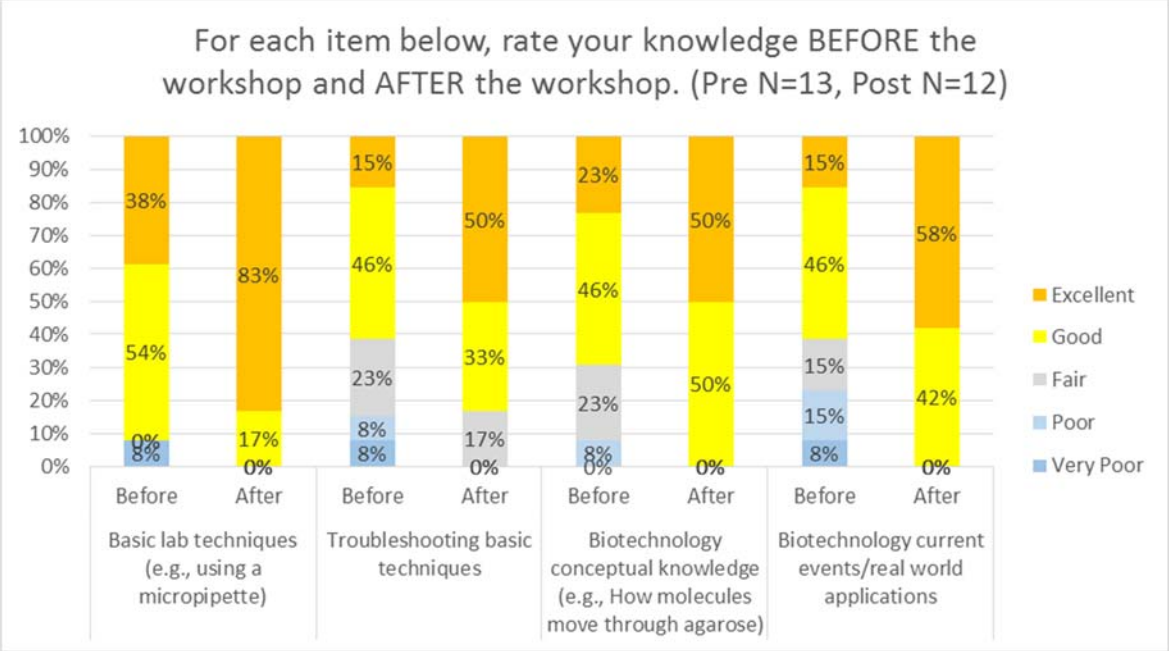
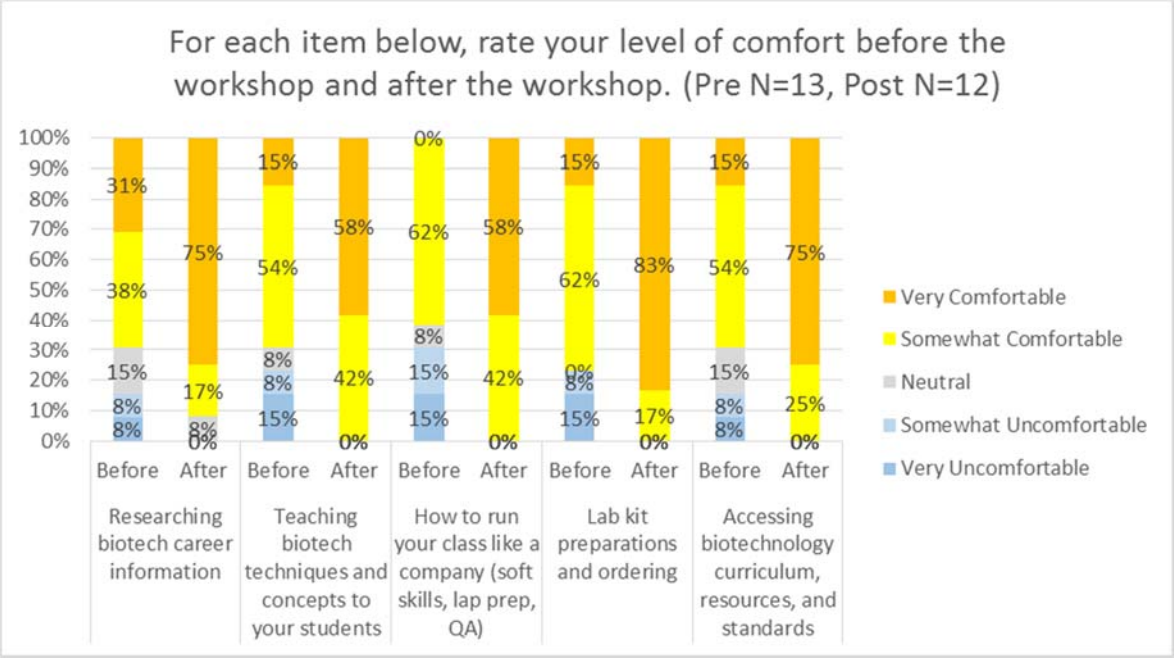


Figure 3: AC2 High School Teacher Workshop: Pre-Post Level of Comfort



On July 31, 2017, a survey was launched of the 14 Mentor Network members who attended the 2017 workshop. As of August 6, 2017, 8 members had responded to the survey (Response rate: 57%). Preliminary results indicate that the Network is highly valued by the members, with comments such as the following:

> *I have really enjoyed the support from all involved in the mentor network.*
>
> *It has been a really good learning experience and a great way to grow as a Biotechnology teacher.*
>
> *Great experience. Got me motivated to be a mentor teacher to help expand biotech in area high schools*

All of the respondents (100%) strongly agreed that the Mentor Network:

- Increased their confidence in the subject content
- Increased their knowledge in the subject content
- Increased their knowledge of how to implement the Biotech Pathway
- Increased their passion for teaching and students
- Increased the likelihood of continuing to build a Biotech pathway in their high schools (as an end goal)
- Supported their needs and concerns through the school year

- Has been a positive experience
- Meets their needs
- Made a positive impact on their courses and student experiences
- Contributed to their successes this past school year
- Impacted their decision to work towards a Biotech Pathway at their schools
- Was vital for the continued expansion of their courses
- Formed a virtual learning community that I look forward to meeting with monthly

All respondents but one (88%) strongly agreed that the Mentor Network:

- Impacted their decision to work towards offering the BACE exam

Respondents wrote that the most valuable aspects of the Network were the collaboration and networking with other teachers, keeping up-to-date on the latest developments in the biotechnology program, technical support, "Biotech Bucks"[1], monthly webinars, and summer workshops.

When asked which aspects of the Network have impacted their courses, respondents gave the following responses (in their own words):

> *I feel more comfortable with the material and the activities. I am able to have resources whenever I have questions or problems.*
>
> *Being able to perform the new labs with those that have performed the labs,*
>
> *I have a lot of support from Jennifer Lazare, and any time I have a question or doubt, I know she will answer it right away.*
>
> *The opportunity to know what other teachers are doing and overall support in Biotech classes.*
>
> *The workarounds tricks and tips to better implement a complicated lab*
>
> *Given me the framework for my class*
>
> *Monthly webinars, summer trainings.*
>
> *There are two main aspects: actual hands-on preparation for labs. (using the equipment that is used in the workforce) and learning about project-based classes. (Getting information from the teachers that actually do this)*

[1] Biotech Bucks is a program where teachers earn credit towards biotechnology supplies for their classrooms through actively participating in the Mentor Network.

Suggestions for improving the Network include adding in-person meetings during the school year, expanding the program (including the equipment loan program) to other geographic areas, and greater outreach/visibility for the Network.

KENTUCKY TEACHER MENTOR NETWORK

In 2016-2017, three teachers were mentored at three high schools in Kentucky. In addition, the Mentor Network researched the status of where biotechnology is located within preexisting pathways and developed a pilot pathway to a Basic Biotechnician Certificate with in the STEM career cluster. The first course of the pathway will be offered in 2017-2018 at Lafayette High School, with the material embedded with an existing advanced biology course for sophomores. The instructor will offer three sections of the course to roughly 90 students.

In 2017-2018, two teachers at two other high schools will implement biotech modules, activities, and/or research. This includes a four-module unit in an advanced forensics class at Woodford County High School.

In addition, in 2016-2017, BCTC attended seven career fairs and outreach events for high schools and conducted a survey of high school science teachers' interest in a biotechnology pathway at the Kentucky Science Teachers Association Conference.

Project Goal 3: Develop new student recruitment pipelines into the industry that include using undergraduate research as a hook in feeder courses to attract and retain students interested in life science careers.

Evaluation Questions

3.1. What best practices does the Circle identify in biotechnology student recruitment? To what extent are the best practices implemented?

3.2. Which aspects of a biotechnology program do students identify as being the most compelling in their decision to enroll?

3.3. How do the efforts (activities 3b, 3c, 3d) affect recruitment and retention in high school and college biotechnology courses and programs?

In 2016-2017, Goal Three focused on using undergraduate research to attract and retain students.

All of the AC2 partner colleges (ACC, Collin College, Del Mar College and BCTC) have incorporated undergraduate research into their courses, with a variety of crowdsourced and locally-based projects. Crowdsourced projects include the Science Education Alliance-Phage Hunters Advancing Genomics and Evolutionary Science (SEA-PHAGES), Prevalence of Antibiotic-Resistance in the Environment (PARE), the International Genetically Engineered Machine Competition (iGEM), and the Small World Initiative.

DEL MAR COLLEGE UPDATE

Del Mar College is the lead for this goal and has the most long-standing research program – in place since 2011. As of 2016-2017, a total of eight courses at Del Mar have incorporated research. Students have presented their data at a variety of conferences and meetings, including the following: American Society for Microbiology, NSF ATE PI Conference, American Association for the Advancement of Science, Community College Undergraduate Research Initiative Student Colloquium, Society for Advancement of Chicanos/Hispanics and Native Americans in Science, and the High Impact Technology Exchange Conference. Students brought home several awards. In addition to presenting data, students have also published in peer-reviewed journals.

Del Mar College is collaborating with a researcher in the SEA-PHAGES project to publish student survey findings; student intentions to continue in science were found to be higher in courses with SEA-PHAGES research than traditional courses without research. Results will be published in 2018.

On April 21-22, 2017, Del Mar College hosted the 2017 AC2 Bio-Link Research Mentoring Workshop. Students presented posters on the first day, and faculty learned best practices for implementing undergraduate research on the second day. A web survey was conducted after the workshop, and 13 participants completed the survey (Response rate: 93%). Selected findings include the following:

- The majority (75%) of respondents were instructors; one (8%) was an administrator; one (8%) was both an instructor and an administrator; and one (8%) was a student. The respondents were primarily from two-year colleges (69%), with 23% from a four-year college or university and one respondent (8%) from a private company.
- The usefulness of the workshop was rated positively by all respondents. (Excellent: 75%, Good: 25%)
- All (100%) respondents agreed that the workshop help them update their skill and knowledge. In written answers, respondents explained that they learned about articulation models, new undergraduate research approaches, increasing student engagement, networking, grant funding, how to collaborate with two- and four-year colleges/universities, bioinformatics, PARE, ideas for student projects, assessment, and funding.
- All but one respondent (92%) planned to implement something they learned. Examples of the things they plan to implement include the following (in the respondents' own words):
  - *1) Improve articulation models, 2) the PARE program.*
  - *Different ways to incorporate students*
  - *Summer internship ideas*
  - *The keynote speaker presented material that I will incorporate into a case study in Gen Bio*
  - *Local partnership, centered on undergrad research and student pipeline development, with a university partner.*
  - *Planning to integrate a project at another school into my current research, provided we can get enough support.*
  - *It will be a research project based on some ideas obtained from the keynote address.*
- Eighty-five percent (85%) of the respondents planned to share the information from this workshop with a total of 552 students, and 62% planned to share the information with a total of 90 colleagues.
- Respondents estimated that they made an average of three new colleague contacts apiece during the networking event and planned to contact two of these contacts later to initiate a working relationship.
- Respondents reported that the most useful aspects of the event were the networking, discussions/success stories, partnerships, bioinformatics session, PARE, and the guest speaker.
- Suggestions for improvement included inviting more attendees, encouraging more interaction between two- and four-year schools, more time for discussions, stricter adherence to the session time limits, and the addition of student sessions.

COLLIN COLLEGE UPDATE

In 2016-2017, Collin College implemented both PARE and SEA-PHAGES into courses, and they revised the lab manuals to reflect these additions. PARE was also incorporated into two research-based general biology labs. The co-PIs from Collin College are attempting to incorporate an inquiry-based lab into all of the general biology labs at the college. Other faculty have expressed concerns about the difficulty of the labs and that it may be a challenge to incorporate all of the content currently in the courses. The co-PIs will continue to work with the other faculty to address their concerns. In addition to incorporating research into courses and labs, Collin College implemented a STEM Research Symposium in both the Fall 2016 and Spring 2017 semesters. Students presented 22 posters in the spring symposium.

As a result of these efforts to incorporate research into their courses, the co-PIs at Collin College have noted increased student engagement and indications of increased student recruitment into the biotechnology program. (They will track student enrollment in Fall 2017 for evidence of increased enrollment.) They have also found increased awareness of student research at their campus.

BLUEGRASS COMMUNITY AND TECHNICAL COLLEGE UPDATE

At BCTC, six courses have incorporated embedded research projects. BCTC has also helped to embed a four-module research unit into two classes at Lafayette High School in Spring 2017; 50 students took this course. In Summer 2017, BCTC delivered seven science camp experiences ranging from one to two days to a total of 294 elementary, middle, and high school students, 82% of whom were underrepresented minority students. Many of these students attended schools that feed into Lafayette High School so the summer camps were used to increase awareness of the biotechnology research opportunities available to them in high school.

Additional changes that BCTC implemented to increase enrollment included offering a flexible lab option where students could complete coursework at a time of their choosing and offering the courses online and through extended campuses to reach rural communities. BCTC also hosted a job fair in March 2017 to showcase local biotechnology companies that resulted in five students being placed into internships. With these efforts to improve recruitment, the program enrollment has hit its maximum capacity of 12.

AUSTIN COMMUNITY COLLEGE UPDATE

ACC incorporated SEA-PHAGES Discovery into two courses in Fall 2016, and the Bioinformatics portion was incorporated in one course Spring 2017. An unduplicated count of 48 students took these course. The positive student response to these activities prompted the ACC Biology Department to formally adopt these research activities; the department is now working towards placing them in all major freshman biology courses. In addition, a Biotechnology/Biology poster session was held at the end of the Fall and Spring semesters.

RECRUITMENT FROM UNDERGRADUATE RESEARCH EXPERIENCES

Data collected by the AC2 partner colleges indicate that undergraduate research experiences may encourage students to enroll in biotechnology programs. (See Table 2) The table below shows that recruitment of students in undergraduate research experiences to biotechnology programs ranged from 9% to 83%. AC2 co-PIs posit that several factors may influence the effectiveness of undergraduate research as a recruiting tool. It appears that research is a more effective recruiting tool when…

- The research instructor has a high level of familiarity with biotechnology and the biotechnology program.
- The research has been active for a longer period of time, giving the opportunity for greater campus awareness of the research opportunities and the connections with the biotechnology program.
- A poster session is organized on campus for students to share their research with other students, faculty, family, and friends.
- The TA in the research program is a second year biotechnology major. Student TAs can make effective champions of the program.
- The biotechnology program offers the opportunity to continue the undergraduate research.
- The biotechnology program includes a paid summer research internship program.
- The biotechnology program offers articulation to four-year colleges or universities, giving students the opportunity to transfer credits and continue their research.

Table 2: Summary of Recruitment from Undergraduate Research Experiences to Biotechnology Programs[2]

College	Before Undergraduate Research				After Undergraduate Research			
	Timeframe	Students Recruited	Total Students in UR	Percentage Recruited from UR	Timeframe	Students Recruited	Total Students in UR	Percentage Recruited from UR
Del Mar	**	**	**	**	Spring 2013 – Spring 2017[3]	31	114	27%
BCTC	Fall 2016	3	6	50%	Spring 2017	5	6	83%
ACC	**	**	**	**	Fall 2016 – Spring 2017	7	74	9%

** Data not available at this time. We are attempting to gain access to historical data for comparison.

[2] Data will be available from Collin College in 2017-2018.

[3] Del Mar College began their undergraduate research program prior to the AC2 grant. Since the grant began in 2015, 20 students have been recruited out of 68 in undergraduate research experiences – or 29%.

We are in the process of collecting historical data for comparison from Del Mar College and ACC. BCTC has one quarter of historical data available. While the sample sizes are low (N=6 for each semester), the results are promising and show an increase from 50% to 83% of the students in undergraduate research experiences choosing to enter the biotechnology program.

Collin College will have recruitment data available starting in Fall 2017. However, while recruitment data is not yet available, a survey of students in the PARE-based biology lab in Summer 2017 (N=18) gives some insight into the students' intention to enroll in further laboratory research courses (72% agree or strongly agree) and the intention to complete a science-related undergraduate degree (78% agree or strongly agree). When asked to describe what they did in the course, responses included the following: "This course was organized in an interesting way. The lab especially was interesting b/c we learned about things that are pertinent to our everyday lives."

Project Goal 4: Implement an entry-level certificate in high schools and community colleges to facilitate entry into bio-technician jobs in industry.

Evaluation Questions

4.1. How many students complete the Certificate (and/or certification exam) and enter biotechnology employment in the region? What are their career trajectories after employment? How do employers rate the readiness of these certificate holders?

4.2. How many teachers earn the teacher certification? To what extent does the certification prepare the teachers to deliver the Entry Level Biotechnology Certificate?

Certificate completions: In 2016-2017, six high school students in Texas completed the certificate, and one was hired at a biotechnology incubator. In 2017-2018, the full certificate pathway will be in place within high schools, with all courses active, so it is expected that the number of completions will rise significantly. The six high school students who completed the certificate in 2016-2017 enrolled in ACC to complete the courses unavailable at the high school.

Biotechnician Assistant Credentialing Exam (BACE): The focus in 2016-2017 was on increasing awareness of the exam and preparing to administer it. Towards this end, during the High School Teacher Workshop, teachers had the opportunity to take the practice exam. Several of these teachers will test BACE questions in their classes in 2016-2017. To increase awareness of the BACE, AC2 helped to advertise a webinar put on by the Bio-Link national center on third-party certification.

BACE will be piloted with 10 students in the fall of 2017.

Project Goal 5: Establish Educational Contract Service Organizations (CSOs) pairing industry projects with student internships and faculty externships to benefit companies, students, and faculty.

Evaluation Questions

5.1. How do the CSOs benefit the regional economy by supporting biotechnology start-ups, in terms of dollar savings, accelerating time to market, and encouraging biotechnology companies to stay in the region?

5.2. How do the CSO and the CSO course affect student and faculty understanding of biotechnology careers and job trends, and the students' readiness for biotechnology employment?

5.3. How well does the CSO course prepare students and faculty to work on industry-based projects?

TEXAS UPDATE

The ACC Bioscience Incubator (ABI) opened in February 2017. ABI began accepting applications in October 2016. A total of 54 companies completed the due diligence. Of these, 10 applied and were evaluated by the steering committee. Eight were accepted, and seven completed contracts. Several jobs were created through ABI: six full-time positions, three part-time positions, and one contractor position. Companies have hosted six student interns and one faculty extern. One intern accepted a full-time job offer from an ABI company. ABI hired four ACC students as summer 2017 interns and hourly employees.

The incubator has produced a variety of educational benefits, including internships, externships, curricula development, hosting student training sessions, and companies that later served as references for interns' later employment searches. A further focus is entrepreneurship education, which is supported through workshops and events (e.g., (Johnson & Johnson - May 25, 2017; PhRMA - June 12, 2017; AC2 High School Teacher Workshop – June 12-16, 2017).

Since moving into the new space, ABI has fulfilled its Emerging Technology Fund contract with the state by filling the incubator with eight companies. As a result, it received the remainder of $4 million in funding.

ABI has conducted two case studies of the impact on companies of being located in the incubator. The case studies found that the incubator contributed to positive outcomes in cost savings and time to market. For the first company saved $156,000 and two months off the expected time to market. The second company saved $230,000 and two to three months. ABI continues to track economic impact indicators, which will be reported in further detail in 2017-2018.

KENTUCKY UPDATE

CSO Construction: BCTC is in the process of developing a CSO, named the Bioscience Collaborative Educational Learning Laboratory (B-CELL). B-CELL is currently under construction, with an estimated completion date in spring of 2018.

CSO Infrastructure: In 2016-2017, BCTC actively worked to develop the infrastructure necessary to support B-CELL. Improvements in infrastructure include establishing a mechanism for invoicing, receiving, and tracking expenditures in collaboration with the BCTC Accounting Department. Budgets and billing rates were also developed.

CSO Baseline Report: In the Fall of 2016, the B-CELL director undertook a series of interviews and site visits to determine a baseline scan of the state of community college CSOs, incubators, and other services for local industry. (See Community College Services Baseline Report, appended to Annual Report.) This report identifies which colleges across the country offer which services, how they measure their impact, the types of internships they offer, how they handle intellectual property, and more.

CSO Partnerships: The exercise of reaching out to the other CSOs and incubators for the CSO Baseline Report led to B-CELL creating productive relationships and even formal agreements to share equipment. These relationships contributed to the CSO Toolkit (see below) and the genesis of the CSO Consortium (see below).

CSO Toolkit: Other CSOs and incubators agreed to share their contracts, memoranda of understanding, leases, equipment lists and more. BCTC will package these into a CSO "Toolkit" of resources for other colleges interested in starting a CSO.

CSO Consortium: The relationships developed during the CSO Baseline Study led to the idea of a CSO Consortium, where member CSOs can share equipment and resources. At the CSO Summit (see below), attendees expressed interest in a CSO Consortium. In 2017-2018, BCTC will continue to explore this idea.

Equipment Acquisition: In 2016-2017, B-CELL purchased its second major piece of equipment, an Agilent Bioanalyzer 2100. BCTC also held an on-site training for Illumina MiSeq. Inviting local industry to the training led to the first paying B-CELL project.

Advisory Committee: B-CELL formed an advisory committee with 5-6 industry and university representatives. The advisory committee held its first meeting in March 2017.

CSO Course: BCTC had planned to pilot its CSO course (Learning Laboratory, BTN 298) in the 2016-2017 year, but the course was cancelled due to low enrollment. The pilot has been rescheduled for the 2017-2018 year.

CSO Summit: BCTC produced a CSO Summit in Austin, Texas, on April 7-8, 2017. The goals of the summit were to 1) review progress since the first CSO Summit was held in 2012 and 2) integrate new information into a CSO Network. There were 38 attendees.

After the Summit, a web survey was conducted, and 12 attendees responded (Response rate: 32%). Of these, 10 represented two-year colleges, two were from private companies, and one was from a governmental organization. Participants had the following feedback about the event:

- All respondents rated the Summit positively (92% Excellent, 8% good)
- All respondents (100%) indicated that the event helped them update their skills or knowledge. Examples of what they learned included the following (in the respondents' own words):
    - *Honestly, I learned so much I cannot list everything. To name a few: organized brain-storming techniques as a method of community of practice, the elements of a CSO network that would motivate participation, a fresh approach to making regulatory compliance possible for CSO/incubators, insight into what an administrator responds to, new ideas for how to involve students in the business of the CSO.*
    - *I learned the principles of setting up and managing as CSO facility. Plus, I learned how others addressed modern workforce skills associated with biomanufacturing sciences.*
    - *(1) Learned what other incubators/schools were doing and how they were doing it (2) Learned how to approach administrators (3) Learned that we need to learn more about best practice business skills for running an incubator (4) Learned that we need to do a better job of networking with mainstream incubators.*
- Eighty-nine percent (89%) plan to implement something they learned at the Summit. Examples include the following:
    - *I plan to build the backbone of a CSO/incubator network with my colleagues from other colleges. I hope we can collectively benefit from a more organized association.*
    - *We will explore opportunities to bring industry into our facilities.*
    - *I plan to establish a stronger collaboration to identify the educational and industry intersection that would benefit a network of biotech efforts.*
- Twelve (12) attendees plan to share the Summit information with 270 colleagues, and 4 attendees plan to share the information with 97 students.
- Attendees made an average of 12 new contacts apiece, and they plan to contact an average of nine contacts apiece after the Summit to develop working relationships.
- Respondents identified the most valuable aspects of the Summit as the networking and learning about other organizations.
- Suggestions for improvement included offering a follow-up seminar after the Summit report is generated, including a presenter from the Department of Labor on workforce skills and bioscience technology trends, CSO financial information, new trends and expertise required by industry, how to connect with universities, which grants to be aware of, detailed discussion of challenges faced by existing CSOs and how they were overcome, legal issues facing CSOs, stem cell manufacturing, and bringing together all national organizations developing CSO relationships.

Project Goal 6: Establish universal (statewide) articulation and reverse articulation among educational partners to facilitate academic transferability and increase degree completion.[4]

Evaluation Questions

6.1. To what extent do the Center's efforts under Goal 6 facilitate credit accumulation and transfer, enhancing the student pipeline from high school through to the university level, including reverse articulation?

6.2. How many students take advantage of the new articulation agreements and the common core courses? How have the articulation agreements affected the time-to-degree and the number of students completing biotechnology programs?

The main focus for Goal Six in 2016-2017 was saving the academic status of the two foundational courses, BIOL 1414 and 1415; the academic status allows the courses to transfer as biology courses for majors. This time consuming effort was ultimately successful, ensuring that team's work in developing articulations with universities will not be in vain.

By the close of the 2016-2017 grant year, AC2 had developed articulation agreements between Texas A&M-Texarkana and Collin College, Del Mar College, and ACC. Agreements between Texas A&M-Texarkana and Lone Star College are in process.

Articulations have been developed between Texas A&M-Corpus Christi and Del Mar College, and an agreement with Collin College is in process. Discussions have begun between Texas A&M-Corpus Christi and ACC. Articulation discussions with Texas A&M-Central are in progress as well.

Meetings have been held to discuss articulation with University of North Texas, Texas Tech University, and Texas State University. AC2 is in the process of negotiating a partnership with the University of North Texas Biochemistry Department.

In addition, the High School Teacher Mentor Network has coordinated articulation agreements between 11 high schools and ACC. In 2016-2017, a total of 292 students used these agreements to earn dual credit or credit in escrow.

[4] This is not a grant goal for Kentucky. In Kentucky, the Council on Postsecondary Education requires all courses to transfer between colleges and universities.

CONCLUSIONS

Overall, the evaluation finds that the AC2 Center has successfully implemented the second year of its grant, making progress on all six grant goals:

Goal One (Community of Practice): The Center completed a needs assessment for the Community of Practice, determined the structure of the CoP and features, and explored options for the CoP online communications hub.

Goal Two (High School Teacher Mentor Networks): The Texas and Kentucky High School Teacher Mentor Networks supported teachers in offering new biotechnology courses, developing new pathways, and setting up new articulation agreements. Members of the network highly value their participation, with comments such as, "It has been a really good learning experience and a great way to grow as a Biotechnology teacher." At the AC2 High School Workshop, participants gained knowledge and comfort in the biotechnology concepts and skills and plan to implement what they learned in the classroom.

Goal Three (Student Recruitment Pipelines – Undergraduate Research): All of the AC2 partner colleges have incorporated undergraduate research into their course and are starting to see an impact on their student recruitment into their biotechnology programs. Students have presented their work at conferences, published papers, and received awards. At the AC2 Bio-Link Research Mentoring Workshop, participants updated their skills and knowledge. They plan to implement something they learned and plan to share what they learned with students and colleagues.

Goal Four (Entry Level Certificate and Biotechnician Assistant Credentialing Exam): Six students completed the certificate in 2016-2017, and the Biotechnician Assistant Credentialing Exam will be piloted with 10 students in Fall 2017. The full certificate pathway will be implemented in 2017-2018.

Goal Five (Contract Service Organizations): In Texas, the ACC Bioscience Incubator opened in February 2017. Since that time, it has hosted seven companies, produced 10 jobs, hosted six interns, and produced a variety of educational benefits for the community. The incubator has helped companies save both money and time to market. In Kentucky, BCTC has made significant progress in developing the Bioscience Collaborative Educational Learning Laboratory infrastructure, brought the community together through the CSO Summit and the CSO Baseline Report, and made progress towards initiating the CSO Consortium and the CSO Toolkit.

Goal Six (Articulations): AC2 had several successes in the area of articulations in 2016-2017, including saving the academic status of the two foundational courses, BIOL 1414 and 1415, along with developing articulation agreements with two campuses of Texas A&M and holding meetings with several other universities. Articulation agreements are in place between 11 high schools and ACC, which have served a total of 292 students.

In sum, 2016-2017 has been a very productive year for the AC2 Bio-Link Regional Center in its progress towards meeting its mission of increasing the number and diversity of well-trained technicians in the

workforce, meeting the needs of this quickly evolving industry, and institutionalizing high quality practices in biotechnology education.