

JOB TRAINING FOR A KNOWLEDGE-BASED ECONOMY

The Quincy College Biotechnology and Compliance Program



**BRUCE VAN DYKE, CHAIR AND FACULTY
ISSO BAYALA, FACULTY
KRISTIN CUTAIA, PROGRAM DIRECTOR**

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EXECUTIVE SUMMARY

According to the Massachusetts Executive Office of Labor and Workforce Development Employment Projections 2006-2016, 60% of all net new jobs created over the next decade in Massachusetts will require an associate's degree or higher. In a so-called 'knowledge-based economy,' such as Boston, post-secondary education plays a critical role in determining labor market success and standard of living. Today, college graduates fill positions once held by high school graduates. As a result, workers in the state who lose their jobs due to the impact of foreign trade or other economic dislocation emerge into an unknown landscape. Industry sectors that are adding or creating jobs and paying a livable wage-- such as healthcare, life sciences and advanced manufacturing--require technical skills and education that are often beyond the average TAA-eligible or dislocated worker. In order to obtain jobs in biomanufacturing, students need a comprehensive educational program. Critical components include: broad laboratory science knowledge in life and chemical sciences; industry-specific, hands-on knowledge in quality control; process development; upstream and downstream processing; good manufacturing practices; laboratory techniques and instrumentation; and critical thinking skills.

In response to this need, Quincy College, located south of Boston, Massachusetts, with the support of a Department of Labor TAACCCT grant, created two academically approved programs: 1) a Certificate in Biotechnology and Compliance and 2) an Associate of Science degree in Biotechnology and Compliance. The programs are unique in that training in traditional manufacturing technology is supplemented with emerging, in-demand, 'single-use' technology. Laboratory equipment is state-of-the art and student learning is facilitated through an integration of virtual lab experiences throughout the curriculum.

Evidence-based Practice

An article published in Evaluate Pharma (2009), predicts that by 2014 half of the top 100 drugs on the market will be made using biotechnology as opposed to traditional small molecule manufacturing. According to the report, the "shift to biotech products as the

industry's growth driver is overwhelming." At the same time, the new federal healthcare bill enables 34 million more people access to healthcare, including prescription drugs. This further increases the demand and the pressures on the pharmaceutical industry to produce more. The two training programs established in this TAACCCT program address the need for jobs for displaced workers as well as the Boston area's growing demand for specialized middle skills technicians. The programs train students in single use systems, or 'disposable' systems that are being adopted for use in the biopharmaceutical industry. Disposable systems create manufacturing environments that allow for: 1) faster changeovers; 2) simultaneous, multiple product manufacturing; 3) less risk of product corruption; and 4) a more rapid expansion of manufacturing capacity.

The Quincy College Programs are based on a model of teaching that integrates a virtual lab environment into learning experiences. The virtual lab creates life-like simulations of actual biomanufacturing equipment and processes and is based on Dr. Cherner's *Active Learning* approach that is characterized by teacher instruction and hands-on lab experience. Research in adult learning (Ausburn), medical training (Paskins and Peile) and engineering (Nirmalakhandan, Ricketts and McShannon) demonstrate that the blended, active learning approach results in improved student learning and achievement.

Evaluation Design

The conceptual framework for evaluation design is based on Kirkpatrick's Four-level Training Evaluation Model. While created in the 1950s, the model is still widely used and adapted to evaluate the effectiveness of training sessions and programs. The model postulates that the value of training can be expressed in four levels. The first level is "Reaction." This refers to participant satisfaction and engagement. The second level is "Learning" and it is defined as the degree to which participants are successful in acquiring the intended knowledge and/or learning the intended skills. "Behavior" is the third level and according to Kirkpatrick, is the application of the training on the job. For the purposes of this program evaluation, application refers to the success of program completers in gaining employment in the field of biomanufacturing. The fourth level is "Results." This is the degree to which the training results in meeting the targeted outcomes and goals. "Results" in this report are the Department of Labor outcome measures and established targets.

Evaluation of the Quincy College Biotechnology and Compliance Program is based on a quasi-experimental model and utilizes a full array of instruments, including, student satisfaction surveys, qualitative data, institutional head count and graduation reports, program completion numbers, employment records and a control group comparison. Quincy College uses the Jenzabar's EX system. EX is a robust enterprise system that supports a wide range of configuration options to manage and combine student information and business office data. The system holds a multitude of data, retains and relates records from inquiry through graduation and beyond, identifies cohort members for tracking, and creates reports on multiple variables such as demographics, financial aid, course enrollment, matriculation records, and time to graduation. Quincy's IT team will tag students who are enrolled in the program to track outcome measure variables through the EX system.

There are three research questions embedded in the implementation study design: 1) Building Programs that Meet Industry Needs: What role does industry play in the development of the credentials; How can partnerships be maintained? 2) Higher Education and Middle-skills Job Training: Are training programs located in institutions of higher education viable? How can the resources to pay for state-of-the art equipment be earned? What conditions need to be in place? 3) Middle-Skills Employment: Are students successful finding jobs in the industry? Do they remain employed at six months? At one year? At two years? As employees, are students promoted? Have they received a pay increase? Do they earn more money upon completion of the program than they earned when they begin the program?

Implementation Findings

In 2013 Bruce Van Dyke, Chair of the Biotechnology and Compliance Program, in conjunction with industry partners, worked with an architect to design the laboratory. Lab renovation and the installation of new equipment were completed by August of 2013. Simultaneously, and in conjunction with key stakeholders, two courses of study (a Certificate program and an A.S. degree program) for preparation in biomanufacturing were designed, approved by Quincy College and ready for implementation by the fall of 2013. Full time faculty and adjunct faculty were hired in the summer of 2013 and the programs were launched that fall. The virtual lab was developed over the course of the next year and

a dedication ceremony was held August 21, 2013. The Quincy College Biotechnology and Compliance program was implemented with fidelity.

The purpose of the Biotechnology and Compliance program is to train students to become biomanufacturing technicians in traditional and single-use manufacturing. Students are taught upstream and downstream bioprocessing from tissue culture through product validation following good manufacturing practices. Students learn relevant industry lab skills, documentation and the operation of equipment and software. Upon successful completion of the program, students may enter the workforce directly as entry-level laboratory technicians or research assistants, or may transfer to a four-year university to continue their studies at the baccalaureate level.

To develop a pipeline of students for the certificate program, a Partnership with Jewish Vocational Services (JVS) was initiated. The partnership established a Bridges to College in Biotechnology program that would recruit a cohort of 12-16 students each year. JVS agreed to prepare the students in basic math, biology and chemistry over a 23-week period. Following the completion of the Bridges Program, students would enter the 9-month Biotechnology and Compliance Certificate Program at Quincy College. Degree students are recruited through the Quincy College Admissions Office. Program staff and faculty also engage in recruitment activities, such as giving presentations to the local career center and community organizations, Quincy College science classes, high school science classes and having a presence at various career and science fairs that occur in the Boston area. Fall enrollment seat count data, as provided by the Quincy College Office of Institutional Research, demonstrate a steady increase in enrollment from 2012 – 2015.

The Quincy College Biotechnology and Compliance Program was designed and imagined from the outset as training for middle-skills employment that would be constructed from a framework of partnership between higher education and private industry. To that end, representatives from Northeast Biomanufacturing Center and Collaborative (NBC²), Shire Human Genetic Therapies, Lonza Biologics, Xcellerex, Inc., and Polymer Corporation all contributed to the design of the lab renovation and the program curriculum. The Massachusetts Life Science Center (MLSC), the Massachusetts

BioEducation Foundation Industry, and the Southshore Workforce Investment Board were also involved with Quincy College from the beginning. This incipient private industry partnership has expanded over time. Partnership agreements are now in place with Albany Molecular Research Incorporated (AMRI), Biogen, Bioevolutions, GE Health, Genzyme, Ironwood Pharmaceuticals, Shire, Massbiologics, Takeda and Unum. Partners are active through such activities as, the provision of on-site tours and internships, the hiring of program completers, program curriculum reviews and participation in the guest lecture series. The strategies used by Quincy College to expand and maintain this vast network of partners may inform other middle-skills job training programs.

In December 2014, the program received a platinum endorsement from the Massachusetts Life Sciences Education Consortium (MLSEC), an initiative formed to facilitate partnerships between the life sciences industry and higher education in order to more effectively match graduating students with the jobs that companies are seeking to fill. The platinum rating highlights the Quincy College program's commitment to excellence, robust industry partnerships and job placement. The MLSEC has also awarded the program with grants: \$100,000 in 2013 and \$500,000 each year from 2014 – 2017.

Despite the successes of BTC, following the cessation of TAACCCT grant funds, the program must find ways to pay for the lab costs, supplies and new equipment to ensure that graduates are trained in the most current methods and processes. Industry partnerships are in place and are a critical component of the sustainability plan. The BTC program faculty is also exploring other ideas to ensure their position. Entrepreneurial efforts include noncredit training for incumbent workers, the preparation of materials and classes to be used in conjunction with the open access virtual lab (including a possible partnership with African countries), contracting with the industry to conduct focused research, contracting with various science groups to manufacture science kits and selling by-products that are produced in the lab.

Next steps for researchers include the collection of long-term data to address issues related to employee retention and salary increases.

INTRODUCTION

Massachusetts and the Greater Boston area have suffered from a loss of jobs due to foreign and other dislocations. According to the Massachusetts Division of Career Services' Rapid Response Services 1st quarter data in 2011, 27.8% of jobs in Greater Boston and 46.3% of jobs in other state regions were eliminated due to 'foreign competition'. The New England Trade Adjustment Assistance Center reports that foreign trade has affected clients from Boston (5 miles north of Quincy) and Braintree (3 miles south). While the range of eliminated jobs varies, middle-skills jobs in such fields as the manufacture of appliances, ophthalmic equipment, surgical and medical instruments and in various other applied science and technology fields represent a significant portion.

Boston is considered a 'knowledge-based economy'. For example, the Massachusetts Executive Office of Labor and Workforce Development Employment Projections for 2006-2016 forecast that 60% of all net new jobs created over the next decade in Massachusetts will require an associate's degree or higher. Workers in Massachusetts who lose their jobs due to the impact of foreign trade or other economic dislocation emerge into a daunting new landscape. Industry sectors that are adding or creating jobs paying a livable wage - such as healthcare, life sciences and advanced manufacturing- require technical skills and education that are often beyond the average TAA-eligible or dislocated worker. In order to obtain jobs in biomanufacturing, students will need broad laboratory science knowledge in life and chemical sciences; industry-specific, hands-on knowledge in quality control; process development; upstream and downstream processing; good manufacturing practices; laboratory techniques and instrumentation; and critical thinking skills. Post-secondary education clearly plays a critical role in determining labor market success and standard of living.

According to the U. S. Bureau of Labor Statistics, national employment in the biotech field is slated to increase 14 percent between 2010 and 2020, creating 11,000 new jobs. In Massachusetts, there were 6,023 technician related jobs in biotechnology in 2008, with an expected increase of 19 percent by 2018 (approximately 327 new jobs each year). According to the Commonwealth Corporation (2010), the life sciences and

biotechnology/biomedical manufacturing sectors face critical job vacancies in Lab Technologist, Medical Equipment Preparer, and Pharmacy Technician over the next five years. Bioplan Associates, Inc., in their *Annual Report and Survey of Biopharmaceutical Manufacturing Capacity and Production* (2009), states that a broad range of clients are facing shortages in biopharma manufacturing and process personnel. More specifically, in the Northeast region, 70% of respondents projected that in the near future they would be hiring downstream manufacturing technicians, upstream manufacturing technicians, microbiology quality control technicians, chemistry quality control technicians, instrumentation/calibration technicians, process development associates, facilities technicians, and validation specialists. Encore Concepts, LLC.'s *Biomanufacturing Needs Assessment Report* (2009) states that more than 200 biomanufacturing technicians would be needed in 2011 and more than four times as many (840) by 2014.

Training new biomanufacturing technicians will help Massachusetts close a gap in the number of middle-skill workers. A July 2010 report, *Massachusetts' Forgotten Middle Skill Jobs: Meeting the Demands of a 21st Century Economy. Skills2Compete*, noted that middle-skill jobs represent the largest share of jobs in Massachusetts (about 44%) and a substantial share of future job openings. Middle-skill jobs are those that require more than a high school diploma but not a four-year degree.

Boston is a biotech center. There are 403 biotech companies just outside the Greater Boston area; 67 companies and 12 biomanufacturers bordering the Boston public transit lines; and 15 biomanufacturing facilities accessible via public transportation from Quincy. The city of Quincy is one of five cities located in the "Life Science Corridor", an initiative of five bordering cities in the Greater Boston area focused on promoting the robust life sciences sector along the "Red Line" of the Massachusetts Bay Transit Authority (MBTA). The biotechnology and compliance program at Quincy College is an industry-driven program, preparing students with the modern workforce skills required to enter the biotechnology industry. The program was developed in response to a growing labor market need for biotechnicians. As the industry grows and matures, it is expected to expand into biofuels, industrial enzymes, bioplastics, and replacement tissues and organs. Altogether, these factors have the biomanufacturing industry gearing up for a significantly increased need for the types of lab technicians who complete the Quincy College Programs.

The Quincy College Programs integrate a complete virtual lab environment into the curricula. The virtual lab creates life-like simulations of actual biomanufacturing equipment and processes and is based on Dr. Cherner's *Active Learning* approach that is characterized by teacher instruction and hands-on lab experience. Lunna Ausburn found that online and hybrid-learning models have a strong affinity with adult learning theory in that they stress the student autonomy, self-direction and focus on relevant learning. A study by Paskins and Peile (2010) explored in depth the features of simulation-based teaching using a whole-body simulator manikin. The authors of this study built on previously published evaluations by analyzing the literature to gain clarity on areas where conflicting reports existed. They concluded that undergraduate medical students perceived that simulation-based teaching led to effective learning and provided a richer understanding of the subject matter. Nirmalakhandan, Ricketts and McShannon provided engineering students with a combination of physical, mathematical, and computer simulation models that allowed them to participate, act, react, and reflect, rather than just listen to lectures, as in traditional classes. Results demonstrated that this blended, active learning approach contributed to improved student learning and achievement and that the approach was appealing to most students.

In the Quincy College programs, the majority of students' training time is spent gaining hands-on experience using the same equipment that they will use in their careers. In order to launch these programs the number/types of equipment and computers needed to be updated and increased so that students could access courses online and use industry-specific software. The labs were designed to contain all of the equipment and software required to simulate actual jobs. Lab technology and equipment was aligned to industry expectations for competent workers. The programs are based on Single Use Systems (SUS), or 'disposable' systems, currently trending in biopharmaceutical manufacturing. SUS manufacturing is state-of-the art practice and SUS training represents state-of-the art workforce preparation.

PROGRAM DEVELOPMENT

Quincy College committed to developing two programs to prepare students to work in the biomanufacturing industry. The certificate is a one-year program and the Associate of Science a two-year program. A commitment to stack and lattice program requirements resulted in a credential program that allows completers to move to the A.S. in Natural Science with the addition of four courses.

Likewise the curriculum of both the credential and A.S. Programs was aligned so that students may transfer to biotechnology programs offered by other Massachusetts community college. Students completing the A.S. degree program are prepared to enter a

four-year biotechnology program and articulation agreements are already in place with the Boston University School of Medicine and the Metropolitan College's Biomedical Laboratory & Clinical Sciences Program.

Another distinguishing feature of the program is its adoption of single-use, or disposable, technology. Training in single-use aligns with trends in biomanufacturing and will provide program completers a substantial lead in the evolving job market. Two faculty members with expertise and experience in the field were hired and College resources pulled into play. The Financial Aid Office assisted with college expenses, the Life Balance Office with personal issues and the Career Services and Workforce Development Office with job search skills and placement. An agreement with Jewish Vocational Services (JVS) was put into place for recruitment of TAA-eligible workers, dislocated workers and other under-skilled adults. JVS offers a Bridges for Colleges and Careers Program and recruited students were enrolled in this program. "Bridges" classes thus serve as an "on ramp" to the Certificate program.

SUMMARY OF PROGRAM ACTIVITIES

- Design state-of-the-art biomanufacturing training lab
- Hire contractor and construct new lab
- Equip and supply new training lab
- Develop and upgrade curriculum
- Recruit project director, faculty and administrator
- Develop online virtual biomanufacturing laboratory
- Recruit, run bridge classes & retain certificate and associate degree students
- Implement biotech & compliance curriculum, including professional developments
- Assessment of program, tracking students, etc..

Knowledge – based economies and middle-skills jobs require preparation beyond high school. In fact A.S. degrees are often considered to be essential for success in middle-skills positions. In order to ensure, however, that the program curricula would be excellent preparation for employment, a partnership with private and public entities was forged at the design stage. The Northeast Biomanufacturing Center and Collaborate, MassBioEd and the Massachusetts Life Science Center were consulted, as were Shire Human Genetics Therapies, Lonza Biologics, Xcellerex and Polymer Private industry expressed their enthusiasm for Quincy College’s efforts by agreeing to assist in curriculum development and revision. They also offered paid internships for students and by agreed to contribute time, supplies and other resources.

Curriculum units were developed based on precise practice tasks learned in sequence and tested against a criterion of competent workplace performance. E-learning tools include simulation-based, customizable virtual laboratories, online courses, innovative performance-based assessment instruments, animations and other interactive resources. These resources integrate with hands-on labs and other traditional curriculum materials. Project simulations imitate all processes and equipment involved in all stages of a manufacturing cycle from creating cell materials to the manufacturing and analysis of the final pharmaceutical and products. The program teaches traditional methods but pays particular attention to single-use systems (SUS). The modular and flexible architecture of the resources and the availability of an easy-to-use authoring tool enable instructors and curriculum developers to adjust the online materials to different student levels and to various educational goals. Students perform online assignments identical to typical workplace tasks; they study underlying fundamental principles and they learn production workflow.

In summary key stakeholder groups were identified as: 1) educational institutions and other organizations, 2) the public workforce system, and 3) employers and industry. Successful efforts were made to pull in representatives to assist with program design, program recruitment and admission, and the stacking and latticing of the curriculum. Table 1 presents a full list of key stakeholders.

Table 1: Key Stakeholders

Key Stakeholder Type	Organization
Employers and Industry	Northeast Biomanufacturing Center and Collaborative (NBC ²)
	Massachusetts Life Science Center (MLSC)
	Massachusetts BioEducation Foundation
	Shire Human Genetic Therapies
	Lonza Biologics
	Xcellerex, Inc.
	Polymer Corporation
Public Workforce System	Southshore Workforce Investment Board
	South Coastal Career Development Administration
	Boston Private Industry Council
	Boston, Quincy, and Plymouth One Stop Career Centers
Educational Institutions and Other Organizations	Boston University
	UMass Boston
	Jewish Vocational Services
	Great Bay Community College
	Massachusetts Life Sciences Education Consortium

RESEARCH METHODOLOGY

Quincy College uses the Jenzar’s EX system. EX is a robust enterprise system that supports a wide range of configuration options to manage and combine student information and business office data. The system holds a multitude of data, retains and relates records from inquiry through graduation and beyond, identifies cohort members for tracking, and creates reports on multiple variables such as demographics, financial aid, course enrollment, matriculation records, and time to graduation. Quincy’s IT team will tag students who are enrolled in the program to track outcome measure variables through the EX system. A satisfaction survey will be administered to students upon program completion.

Quincy College’s Office of Institutional Research conducts an annual survey of graduates six to nine months after students receive their degrees. The response rate is over 40 percent. The survey gathers data about students’ continuing education and employment,

including job title, salary, relationship of their position to their field of study, and how well their education prepared them for their position. In addition to descriptive statistics, the outcome evaluation methodology will also utilize a quasi-experimental analysis, employing the use of a comparison cohort. Together, data will measure program outcomes and provide information on how the biotechnology and compliance curriculum moves graduates into the biotech industry. Program outcomes and goals were established by faculty and are displayed in Table 2.

Table 2: Program Outcomes and Established Goals				
Outcome Measure	Y1	Y2	Y3	Total
Unique participants served.	22	44	57	123
Completing a TAACCCT-funded program.	12	9	32	53
Retained in their program of study or another.	0	1	13	14
Completing credit hours	21	44	51	116
Earning credentials	12	9	32	53
Enrolled in further education after completing grant funded program of study	3	1	-	4
Employed after program of study completion	6	8	15	29
Retained in employment after program of study	6	8	15	29

The conceptual framework for evaluation design is based on Kirkpatrick’s Four-level Training Evaluation Model. While created in the 1950s, the model is still widely used and adapted to evaluate the effectiveness of training sessions and programs. The model postulates that the value of training can be expressed in four levels. The first level is “Reaction.” This refers to participant satisfaction and engagement. The second level is

“Learning” and it is defined as the degree to which participants are successful in acquiring the intended knowledge and/or learning the intended skills. “Behavior” is the third level and according to Kirkpatrick, is the application of the training on the job. For the purposes of this program evaluation, application refers to the success of program completers in gaining employment in the field of biomanufacturing. The fourth level is “Results.” This is the degree to which the training results in meeting the targeted outcomes and goals (See Table 2).

Evaluation of the Quincy College Biotechnology and Compliance Program is based on a quasi-experimental model and utilizes a full array of instruments, as presented in Table 3, “Biotechnology and Compliance Program Comprehensive Assessment.”

Table 3: Biotechnology and Compliance Program Comprehensive Assessment

Training Model Evaluation Levels	Evaluation Instruments
Behavior	Student Satisfaction Survey Qualitative Data
Learning	Fall-to-fall Retention Data On Time Graduation Data Program Completion Data
Behavior	Employment Records Employment Retention Wage Increases
Results	Program Outcome Descriptive Statistics Control Group Comparison

Research Questions

1. Building Programs that Meet Industry Needs: What role did industry play in developing the credentials? How can partnerships be maintained?
2. Higher Education and Middle-skills Job Training: Are training programs viable? How can the resources to pay for state-of-the art equipment be earned? What conditions need to be in place?
3. Middle-Skills Employment: Are students successful finding jobs in the industry? Do they remain employed at six months? At one year? At two years? As employees, are students promoted? Have they received a pay increase? Do they earn more money upon completion of the program than they earned when they began the program?

OUTCOMES

In 2013 Bruce Van Dyke, Chair of the Biotechnology and Compliance Program, in conjunction with industry partners, worked with an architect to design the laboratory. Lab renovation and the installation of new equipment were completed by August of 2013. Simultaneously, and in conjunction with key stakeholders, two courses of study (a Certificate program and an A.S. degree program) for preparation in biomanufacturing were designed, approved by Quincy College and ready for implementation by the fall of 2013.

The purpose of the Biotechnology and Compliance program is to train students to become biomanufacturing technicians in traditional and single-use manufacturing. Students are taught upstream and downstream bioprocessing from tissue culture through product validation following good manufacturing practices. Students learn relevant industry lab skills, documentation and the operation of equipment and software. Upon successful completion of the program, students may enter the workforce directly as entry-level laboratory technicians or research assistants, or may transfer to a four-year university to continue their studies at the baccalaureate level. One full-time faculty member was hired in July 2013 and two adjuncts to teach courses to launch the program in that fall semester were also recruited and signed.

Certificate and A.S. Programs in Biotechnology and Compliance

The Certificate and A.S. programs are open access. However, students do need a science and math foundation to be successful. A minimum grade of “C” in Biology and Chemistry is preferred. If a student has met all of the prerequisites for the BTC program with the minimum grades, then the student is able to enroll in BTC courses. If a student has a Bachelor of Science and wants to forgo taking the prerequisites, they must see the Program Chairman for approval to enroll in either the certificate or associate in science program. If a student has limited English proficiency, the Program Chair may request a LOEP assessment and based on the score, the Chair can either recommend ESL classes at Quincy College or refer the student to free, ESL community resources. The ESL LOEP Test is an assessment for international students whose first language is not English.

The certificate program is comprised of twenty-two credits and is intended to be completed in 9 months. The A.S. Program includes sixty-four to sixty-six credits and is a two-year program.

To develop a pipeline of students for the certificate program, a partnership with Jewish Vocational Services (JVS) was initiated. Jewish Vocational Services’ states their mission on their web site (www.jvs-boston.org): *Empowering individuals from diverse communities to find employment and build careers, while partnering with employers to hire, develop, and retain productive workforces.* JVS was founded in 1938 and today serves students from across 67 nations and approximately 59 languages. JVS provides training and coursework to prepare students for a variety of employment opportunities, including healthcare and multiple vocations. JVS has years of successful experience in workforce development and seemed a natural fit for the recruitment and preparation of students for the certificate program in Biotechnology and Compliance.

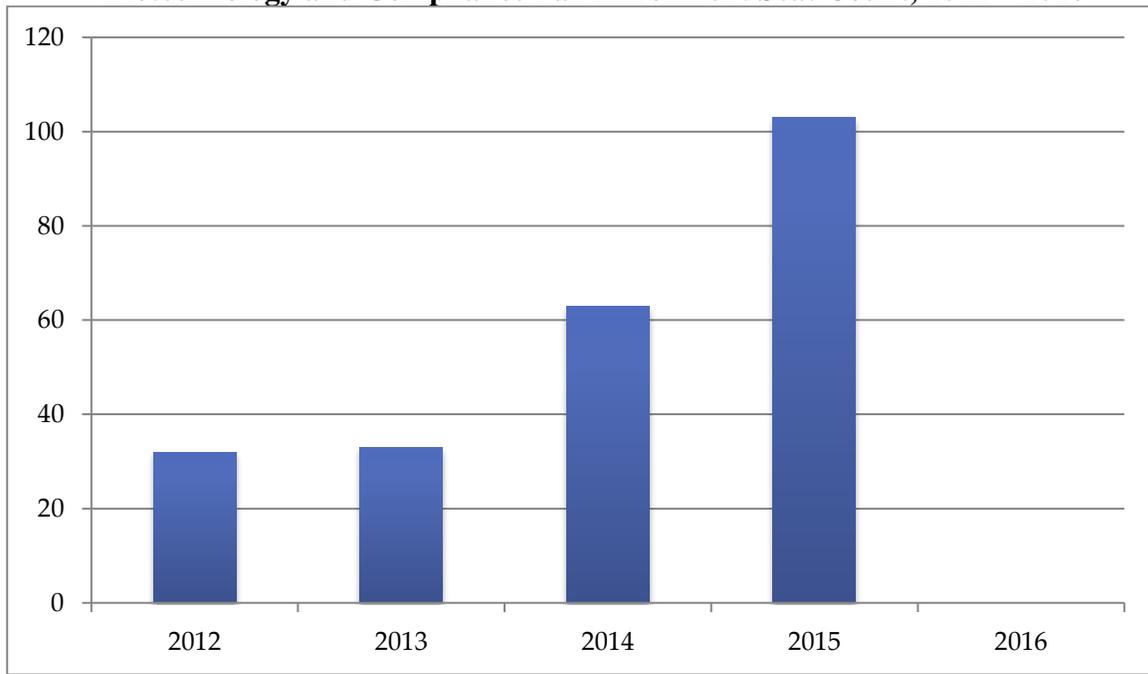
The partnership established a Bridges to College in Biotechnology program that would recruit a cohort of 12-16 students each year. JVS agreed to prepare the students in basic math, biology and chemistry over a 23-week period. Following the completion of the Bridges Program, students would enter the 9-month Biotechnology and Compliance Certificate Program at Quincy College. As the programs (Bridges and Certificate) ran simultaneously, certificate students did not register at Quincy College for the traditional fall and spring semesters. Table 4 displays student numbers and dates of completion for each of the partners.

Table 4: JVS Bridges and Quincy College Certificate Programs, Dates and Numbers of Students

Enter JVS Bridges to College	Number	Enter Quincy College BTC Certificate Program	Number of Completers
Spring 2013	12	July 2013– April 2014	12
Spring 2014	14	July 2014- April 2015	12
Fall 2015	13	January 2015- October 2015	12
Spring 2015	12	July 2015 – April 2016	12
Fall 2016	12	January 2016 – October 2016	12

Degree students are recruited through the Quincy College Admissions Office. Program faculty also engage in recruitment activities, such as giving presentations to Quincy College science classes, high school science classes and having a presence at various career and science fairs that occur in the Boston area. The A. S. degree in Biotechnology and Compliance began at Quincy College in 2010. The TAACCT grant supported a significant updating of the degree to include single-use technology and a renovation of the lab to include state-of-the art equipment. Typically 12 – 14 students complete the A.S. degree each year. However, fall enrollment seat count data, as provided by the Quincy College Office of Institutional Research, demonstrate a steady increase in enrollment from 2012 – 2015. This increase demonstrates the steady growth that has occurred since the initiation of the single-use program. Table 5 displays Biotechnology and Compliance Fall Enrollment Seat Count, 2012 – 2016.

Table 5
Biotechnology and Compliance Fall Enrollment Seat Count, 2012 – 2016



Retention and Graduation of Students

The BTC program tracks outcomes for the Department of Labor (DOL) Grant and requires a quarterly narrative and an annual report at the end of each

reporting period. The outcomes are tracked in a program database that stores student demographic information, employment information, and all outcomes required for DOL reporting. Student information is gathered via survey when a student begins the BTC Introduction to Biotechnology class. The survey information is entered in a Goggle tracker. The program uses Jenzabar student records to complete credit hour reporting and completion. Employment information is tracked through graduate surveys and student self-reporting. Associate Vice President of Institutional Research, Dr. Kim Puhala prepared a report regarding graduation/completion rates.

Table 6 “Fall to Fall Retention (or Completion of Program)” displays student retention from fall to fall, i.e., a student who enrolled in the fall of 2013 enrolled (or had completed the program) in the fall of 2014. A “Cohort” consists of students who took BTC 101 during the semester indicated on the table. Students are defined as part-time or full-time based on the number of credits taken during the indicated semester. Students taking 12 or more credits are categorized as full-time. Retention rates are calculated as the % of students who were enrolled in (or completed their program by the Fall term one semester after taking the BTC 101. Table 7, “On Time Graduation Rates of Certificate and A. S. Students” displays graduation data. Rates are calculated following the IPEDS definition of having graduated within 150% of normal time (3 years for Associate’s degrees and 1.5 years for certificate completion. Rates are calculated assuming a start date of the Fall semester prior to taking BTC 101. Table 7, “Graduation Rates of Certificate and A.S. Students” displays program completion outcomes. These data show the number of students who actually completed their programs, although not necessarily in an on-time manner.

**Table 6
Fall-to-Fall Retention**

Fall Cohort	Part-time Students	Fall Returning Students	Part-time Rate	Full-time Students	Fall Returning Students	Full-time Rate
2012	3	3	100%	4	2	50%
2013	11	10	90.9%	18	8	44.4%
2014	28	23	82.1%	9	7	77.8%
2015	23	16	69.6%	10	7	70.0%

Table 7
On-Time Graduation Rates of Certificate and A. S. Students

Cohort	Part-time	Number of Program Graduates	Graduation Rate for Part-time Students	Full-time	Number of Program Graduates	Graduation Rate for Full-time Students
2012	3	3	100%	4	2	50%
2013	11	6	54.5%	18	8	44.4%
2014	28	3	10.7%	9	2	22.2%
2015	23	6	26%	10	10	100%

The Quincy College Office of Institutional Research’s records provide a snapshot of student retention and on-time graduation. These data, however, are not actual reflections of program completion because of some of the unique characteristics of the Biotechnology and Compliance Program. The first issue is related to the nonconforming calendar of the certificate program. Since it is a nine-month program, students who complete the program as intended will not be represented in the twelve-month fall-to-fall retention data. The second issue is related to Quincy College’s graduation policy. The reported graduation rates are low, as the first three cohorts of completers did **not** apply for graduation. Many of these students are immigrants and either did not understand the process of applying for graduation or found the \$150 graduation fee burdensome. Since April 2015, the program has increased communication with BTC certificate students to help them understand the college graduation process and to encourage them to apply for graduation so that they can receive their graduation credentials. As a result, the number of BTC certificate students applying for graduation has increased significantly and 10 out of 12 participated in graduation in May 2016. (The other 2 members of this class are choosing to continue their education and take classes to earn their A.S. degrees).

A more informative view of student progress is reflected in the number of students who completed their programs. These data are presented in Table 8, “Program Completion Rates of Certificate and A.S. students. Data demonstrate students admitted to both programs are completing at a high rate.

Table 8

Program Completion Rates of Certificate and A.S. Students

Certificate Students	Admitted	Completed	%	A.S. Students	Admitted	Completed	%
2012	n/a	n/a	-	2012	n/a	n/a	-
2013	12	12	100%	2013	7	7	100%
2014	14	12	86%	2014	20	18	90%
2015	17	15 (12 JVS)	88%	2015	17	15	88%

Other relevant data pertaining to the Biotechnology and Compliance Program student outcomes relate to employment success and pursuit of educational goals either within the institution or through transfer. Table 9, “Other Student Outcomes Across Programs” presents these data. Data demonstrate that students are taking advantage of transfer opportunities to 4-year institutions.

Table 9
Other Student Outcomes Across Programs

Year	Employed	Continued Education	Transfer
2012-13	6	3	Transferred to Boston University Metropolitan College Biomedical Science Program
2013-14	12	1	Transferred to Boston University Metropolitan College Biomedical Science Program
2014-15	11	4	Transferred to Boston University Metropolitan College Biomedical Science Program
2015-16	10	1	Transferred to Bridgewater State University

Student Demographics

Students in the Biotechnology and Compliance Programs are ethnically, culturally, and economically and gender diverse. Data reported to the Department of Labor in Year 3 of this grant are displayed in the following table.

Table 10: Student Demographics, From Year 3 Department of Labor Annual Report for the Quincy College DOL TAACCCT grant program		
Gender	Male	65
	Female	58
Ethnicity / Race	Hispanic/Latino	7
	American Indian or Alaskan Native	0
	Asian	22
	Black or African American	29
	Native Hawaiian or Other Pacific Islander	0
	White	41
	More Than One Race	7
	Full-Time Status	109
	Part-Time Status	14
Other Demographics	Incumbent Workers	29
	Eligible Veterans	3
	Participant Age (mean)	32
	Persons with a Disability	2
	Pell-grant eligible	43

OUTCOMES IMPACT

DOL Outcome Measures

Table 11: Performance Measure Outcomes				
F 1 2 3: Outcome Measure (determination)	Y 1	Y 2	Y 3	Total
# Unique participants served. <i>(18 start, 20/ year each year among both programs)</i>	22	44	57	123
# Completing a TAACCCT-funded program. <i>(Certificate: assumes a 70% on time completion rate/ 80% within 1.5 years. Assoc: assumes 50% on-time completion rate/ 70%; completion rate within 1.5 years)</i>	12	9	32	53
# retained in their program of study or another. <i>Assumes 75% retention rate</i>	0	1	13	14
# Completing credit hours <i>(Assumes 10% of drop-outs earning no credits)</i>	21	44	51	116
# Earning credentials <i>(Assumes 5% of students transferring prior to obtaining degree or certificate)</i>	12	9	32	53
# Enrolled in further education after completing grant funded program of study <i>(Assumes 20% continuing on)</i>	3	1	-	4
#Employed after program of study completion <i>(Assumes 30% non-incumbent workers. 80% placement rate based on post-graduation surveys)</i>	6	8	15	29
#Retained in employment after program of study completion <i>(Assume 10% no longer employed in the second and third quarters).</i>	6	8	15	29

The Quincy College Office of Institutional Research conducted a survey of BTC and Medical Technology students in September of 2015, in order to compare the completion of programs, employment in their field of study and the average wage rates after completion of their program of study. The Quincy College medical technology program was selected as being parallel to BTC in that students are prepared for middle-skilled jobs and medical field employment opportunities abound.

Table 12: Comparison Group Results Table

Outcome Measure	A. S. Biotechnology Students		A. S. Medical Technology Students	
	N	%	N	%
Employment after Completion of Program	9 out of 11 surveyed	81%	5 out of 11 surveyed	45%
Earnings after Completion of Program	\$19.06		\$24.05	
Employment Retention six months out	9 out of 11 surveyed	81%	5 out of 11 surveyed	45%
Credit Attainment Rate	11 out of 11 surveyed	100%	9 out of 11	81%
Attainment of Degree	11 out of 11 surveyed	100%	9 out of 11	81%
Enrollment in further Education	6 out of 11 surveyed	56%	2 out of 11 surveyed	18%

Results demonstrate that the biotechnology and compliance program had a higher rate of employment, 81 % compared to 45%. Biotechnology and compliance students had a 100% degree attainment rate compared to 81% for the Medical laboratory technology students. The biotechnology students pursued enrollment in further education at a much higher rate than the medical laboratory technician students.

Satisfaction

Associate Vice President of Institutional Research, Dr. Kim Puhala prepared a report on student satisfaction in 2015 for the BTC Program. Surveys included in the report included responses from students who completed their programs from 2012 – September of 2015. Satisfaction was defined on five dimensions: 1) overall; 2) classroom instruction; 3) technology and the labs; 4) access to faculty and 5) student support for study habits and skills. The results of the survey are displayed in the tables below: Table 13 “Overall Satisfaction,” Table 14, “Satisfaction with Classroom Instruction;” Table 15, “Satisfaction with the Adequacy of Technology in the Classrooms and Labs;” Table 16, “Satisfaction with Access to Faculty; and Table 17, “Satisfaction with the Availability of Help to Improve Study Habits and Skills.” Note: No students self-identified as Biotechnology and Compliance majors in the 2013 student satisfaction survey. In 2012 students were not asked about their satisfaction with lab technology or study skills assistance. Lab renovation and updating as well as tutors for students were initiated in 2013 with the award of the TAACCT grant and were reflected in satisfaction surveys beginning in 2013.

Table 13: Overall Satisfaction

	2012 (n=8)	2013 (n=0)	2014 (n=9)	2015 (n=21)
Much worse than I expected	0.0%	n/a	0.0%	9.5%
About what I expected	37.5%	n/a	44.40%	42.9%
Better than I expected	37.5%	n/a	44.40%	38.1%
Much better than I expected	25.0%	n/a	11.10%	9.5%
TOTAL	100.0%	n/a	99.9%	100.0%

Table 14: Satisfaction with Classroom Instruction

	2012 (n=8)	2013 (n=0)	2014 (n=9)	2015 (n=21)
Not very satisfied	0.0%	n/a	0.0%	4.8%
Somewhat satisfied	12.5%	n/a	33.3%	9.5%
Satisfied	62.5%	n/a	33.3%	57.1%
Very Satisfied	12.5%	n/a	33.3%	9.5%
TOTAL	87.5%	n/a	99.9%	80.9%

Table 15: Satisfaction with the Adequacy of Technology in the Classrooms and Labs

	2012 (n=8)	2013 (n=0)	2014 (n=9)	2015 (n=21)
Strongly Disagree	Not asked	n/a	0.0%	4.8%
Disagree	Not asked	n/a	0.0%	14.3%
Neutral	Not asked	n/a	33.3%	33.3%
Agree	Not asked	n/a	33.3%	28.6%
Strongly Agree	Not asked	n/a	33.3%	9.5%
Total	Not asked	n/a	99.9%	90.5%

Table 16: Satisfaction with Access to Faculty

	2012 (n=8)	2013 (n=0)	2014 (n=9)	2015 (n=21)
Not very satisfied	0.0%	n/a	0.0%	14.3%
Somewhat satisfied	0.0%	n/a	22.2%	14.3%
Satisfied	62.5%	n/a	44.4%	52.4%
Very Satisfied	12.5%	n/a	11.1%	0.0%
TOTAL	75.0%	n/a	77.7%	81.0%

Table 17: Satisfaction with the Availability of Help to Improve Study Habits and Skills.

	2012 (n=8)	2013 (n=0)	2014 (n=9)	2015 (n=21)
Strongly disagree	Not asked	n/a	0.0%	4.8%
Disagree	Not asked	n/a	0.0%	14.3%
Neutral	Not asked	n/a	11.1%	23.8%
Agree	Not asked	n/a	44.4%	33.3%
Strongly Agree	Not asked	n/a	44.4%	14.3%
Total	Not asked	n/a	99.9%	90.5%

Results demonstrate that overall satisfaction rates are high. In only one year, 2015 did any students (9.5%) indicate that their overall satisfaction was less than expected. In all other cases overall satisfaction met or exceeded expectations. Data on satisfaction with classroom instruction demonstrates that over 66% of the students were either “satisfied” or “very satisfied” with the instructional component of their program. The technology component was viewed positively by 66.6% of the students in 2014 and by 38.1 % of the students in 2015. In both of these years 33.3% of the students were neutral as regarded the technology component. The majority of students in all years reported that

they were “satisfied” or “very satisfied” with access to faculty. In 2014, 88.8% of respondents agreed or strongly agreed that they were satisfied with the availability of help to improve study skills. In 2015 46.6% of the respondents likewise agreed or strongly agreed.

Overall, data demonstrate a high degree of satisfaction with classroom instruction, access to faculty and assistance with study skills. Data from 2015, however, raise questions about student satisfaction with the overall program as well as with the perceived adequacy of lab equipment. The interpretation of these data, however, is limited by the fact that the program is new and trends cannot be discerned with only two years of data. When viewed as a set, the data indicate that the Biotechnology and Compliance Program is having a generally positive impact on students’ educational experiences.

Qualitative data from program graduates and employers provide further evidence about the positive impact of the Biotechnology and Compliance programs on students’ lives. While feedback is informal, the close partnership between the Quincy College faculty and the biomanufacturing industry provides multiple opportunities for interaction. Examples of comments received include the following.

- *There is not one thing that they (Shire) have trained me on that I didn’t already learn from the BTC program. **Robert Mitchell, Quincy College BTC graduate***
- *My managers are very impressed with how well I can do things (skills) and the knowledge that I have. **Katie Beal, Quincy College BTC graduate***
- *The first thing that attracted me to the Quincy College program was the laboratory and equipment. bioreactors, automation, chromatography, filtration etc., I think we’ve located a goldmine of talent for the future of Biogen in Massachusetts. **John Dirienzo Director, Next Generation Manufacturing Project Management, Biogen***
- *Good job Bruce, you have put together an excellent program. **Parrish Galliher, Founder and Chief Technical Officer Xcellerex (a GE subsidiary)***

- I supervise Katie, and work closely with Alex in upstream manufacturing here at Shire. I will say that, without a doubt, these two came into the role with a far greater understanding than many of the entry-level technicians who come out of the bevy of certificate programs in the area. Their knowledge of Quality Systems, cGMP's and general biotechnology manufacturing operations has made them a great asset almost immediately. Typically, these are items we spend months training new personnel on. ... I have advised other supervisors to keep an eye out for personnel coming out of your program as they do shine above the rest, considerably.* **Carl E. Soderberg, Manufacturing Supervisor, Upstream Cell Culture & Ultra Filtration, Shire**
- A highly trained and skilled workforce is essential to Shire... we believe it is important to partner with educational institutions and workforce development non-profits to ensure that students are acquiring the specialized skills needed in an ever changing biotech industry. We are proud of the relationship that we have with Quincy College and the Shire employees that have come through their program.* **Pat Sacco, Senior Vice President & Head Internal Manufacturing, Shire**
- The first thing that attracted me to the Quincy College program was the laboratory and equipment. bioreactors, automation, chromatography, filtration etc. ..., I think we've located a goldmine of talent for the future of Biogen in Massachusetts.” **John Dirienzo, Director, Next Generation Manufacturing Project Management, Biogen**
- We had several entry level jobs (Manufacturing Technician I) open in Production... one group who initially interviewed [the] candidate felt she was overqualified for the Manufacturing Technician I role... She ended up being the successful candidate for the higher level Manufacturing Technician II position. We are enthusiastic about her joining us here at MassBiologics.* **Frank Fazio, Deputy Director Manufacturing, Mass Biologics**

ADDITIONAL FINDINGS

Partnership with Private Industry

Research Question

Building Programs that Meet Industry Needs: What role did industry play in developing the credentials? How can partnerships be maintained?

The Quincy College Biotechnology and Compliance Program was designed and imagined from the outset as training for middle-skills employment that would be constructed from a framework of partnership between higher education and private industry. To that end, representatives from Northeast Biomanufacturing Center and Collaborative (NBC²), Shire Human Genetic Therapies, Lonza Biologics, Xcellerex, Inc., and Polymer Corporation all contributed to the design of the lab renovation and the program curriculum. The Massachusetts Life Science Center (MLSC), the Massachusetts BioEducation Foundation Industry, and the Southshore Workforce Investment Board were also involved with Quincy College from the beginning.

Although partnerships are established around a common goal, a challenge that is often encountered is finding the time to maintain the relationships. Partners are typically not co-located and those involved in trying to maintain the partnership on a week-to-week basis are already responsible full-time to their institutions. Partnerships require a redistribution of workload or, more commonly, adding on to an already full workload. These challenges often result in dissolution of the partnership over time.

On the contrary, however, the Quincy College and private industry partnership has expanded over time. Partnership agreements are now in place with Albany Molecular Research Incorporated (AMRI), Biogen, Bioevolutions, GE Health, Genzyme, Ironwood Pharmaceuticals, Shire, Massbiologics, Takeda and Unum. Partners are active through such activities as, the provision of on-site tours and internships, the hiring of program completers, program curriculum reviews and participation in the guest lecture series. Quincy College faculty and staff have been remarkably inventive in finding ways to reduce the obstacles of distance and time. The strategies that they employed represent promising practices for other partnerships between higher education and industry.

- Understanding Location

Boston is a biotech center. There are 403 biotech companies just outside the Greater Boston area; 67 companies and 12 biomanufacturers bordering the Boston public transit lines; and 15 biomanufacturing facilities accessible via public transportation from Quincy. The city of Quincy is one of five cities located in the “Life Science Corridor”, an initiative of five bordering cities in the Greater Boston area focused on promoting the robust life sciences sector along the “Red Line” of the Massachusetts Bay Transit Authority (MBTA). The biotechnology and compliance program at Quincy College is an industry-driven program, preparing students with the modern workforce skills required to enter the biotechnology industry. Quincy College is physically located in a place to build relationships with established, as well as smaller, start-up companies.

- Employment of industry representatives as adjunct faculty

The BTC Program hired representatives from private industry to teach two classes when the program was launched in the fall of 2013. This practice has continued with the result that private industry has become more invested in the program both in its curriculum and its results. As adjunct faculty, the private industry representatives have become more acquainted and more engaged with student success. Being on campus and becoming a part of the BTC program has also increased opportunities for the instructors to establish and build relationships with the full-time program faculty.

- Speaker Series

Each semester representatives from private industry are invited to give a presentation to program faculty and students. Private industry has responded positively to this initiative as a way to promote their company and their achievements. At the same time program faculty welcome the opportunity to interact with practicing professionals and to stay current with the application of technology in the field. Students, of course, benefit as their academic experiences are supplemented with relevant information about the application of the manufacturing processes.

THE QUINCY COLLEGE BIOTECHNOLOGY AND COMPLIANCE PROGRAM

Speaker Series

FEATURING BIOMANUFACTURING INDUSTRY EXPERTS



WEDNESDAY, MARCH 9TH 10:00 A.M.

PARRISH M. GALLIHER
CTO Upstream and Founder Xcellerex Inc. at GE Healthcare Life Sciences



TUESDAY, MARCH 22 AT 2:00 P.M.

DAVID G. SMITH
Sr. Recruiting Partner at Biogen



WEDNESDAY, APRIL 6 AT 10:00 A.M.

FRANK FAZIO
Deputy Director Manufacturing at MassBiologics



FRIDAY, APRIL 8 12:00 P.M.

JOHN DIRIENZO
Director, Next Generation Manufacturing, Project Management at Biogen



GE Healthcare



MassBiologics

UMASS MEDICAL SCHOOL
Medicine for Better Lives

- Industry Tours

Each spring semester students preparing for graduation tour 3 – 5 manufacturing facilities in order to gain a broader understanding of the biomanufacturing process on a larger scale of production. In the past 3 years, students have toured Shire, Biogen, Takeda, GE Health Science, Ironwood Pharmaceuticals and Bioinnovations. These tours provide students with a first-hand look at the equipment used in the partnership industry's manufacturing process. Frequent comments from students relate to the differences in lab set-ups and the differences in corporate culture that they observe among the diverse campuses. Students have also noted that their comfort level for interviews is boosted after having seen the actual physical facilities of the various companies. For private industry, the tours are an opportunity for recruitment as they become better acquainted with students as potential interns and future employees.



Tour of Mass Biologics, April 2016

- Focus on the lab as the key to worker training
The biomanufacturing industry requires skilled workers. Further, as equipment and technology is developed within this dynamic field, workers must be capable of learning new skills and acquiring new knowledge. Shire, for example, notes under its “Education and Experience Requirements,” *Normally requires a high school diploma and 2-4 years related industry experience or an Associate’s Degree in Life Sciences/Engineering field with 1 year of GMP Manufacturing experience. Biotech Certificate preferred.* Companies in the industry have a vested interest in retaining skilled employees. They offer benefits, such as health insurance, and attractive opportunities for promotion and salary increases. Some companies offer employees assistance in obtaining four-year degrees in the sciences. The biomanufacturing industry in Boston understands that partnerships with higher education for training entry-level employees are critical to their success but how to build and maintain

partnerships is not necessarily obvious. Quincy College faculty understood that the lab facilities are the hub of the training program and a point from which private industry could quickly grasp the nature of the intent of the program. Working together to design and renovate the lab with single-use state-of-the art equipment, set partnerships in motion and has continued to fuel interest and involvement. To maintain lab quality, partners, over the last three years, have donated supplies, equipment and money. Without these donations, it is unlikely that Quincy College would have been able to build or maintain such a state-of-the art facility.

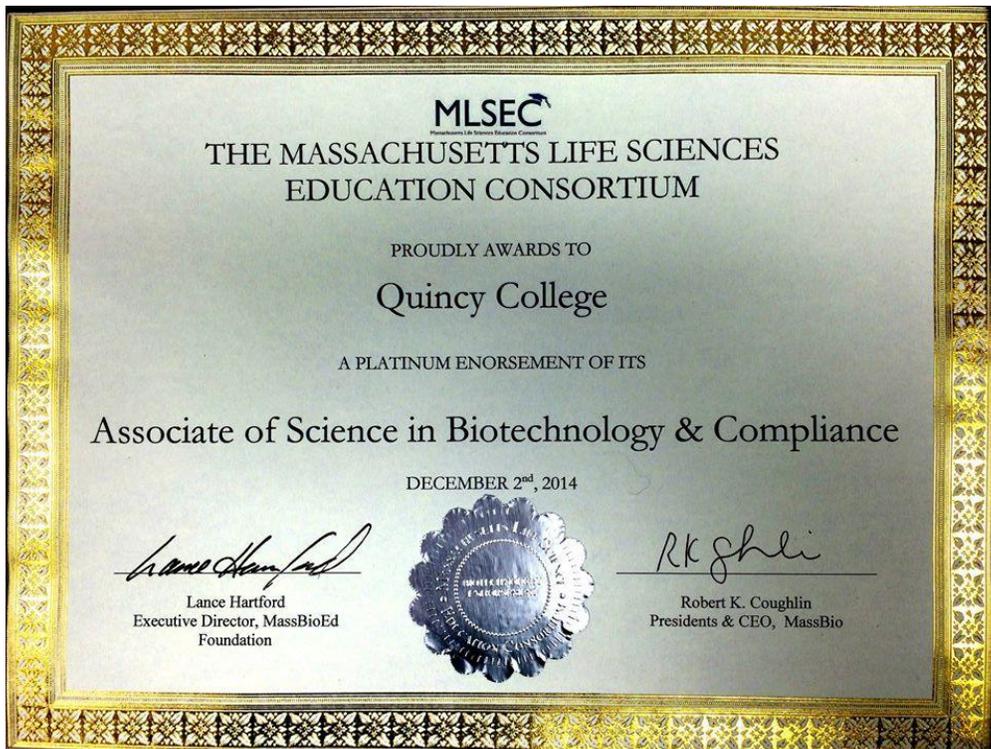
Program of Excellence

An excellent worker-training program cannot be isolated on a college campus, rather it will be linked throughout the larger area to various organizations and entities that are promoting and operating within the industry. In addition to private industry (See Partnership with Private Industry), Quincy College has worked diligently at establishing a presence and a reputation in the Greater Boston area. Examples of their efforts include the following.

- The BTC program hosts industry speakers at the annual **Biomanufacturing Career Fair** held every spring either before or right after students graduate from the program. Students benefit from the networking opportunities and job search tools that are provided. Industry recruiters and human resource professionals meet students and review the company hiring process, provide resume critiques and offer interviewing tips.
- Each year during the Cambridge Science Fair, the BTC program joins the **Quincy Center for Innovation** to promote the sciences for people in the city of Quincy and the south shore.
- A partnership with **Jewish Vocational Services** was put into place to provide short courses in biology, chemistry, microbiology and math to prepare students to enter the certificate program.
- Students are invited to participate in the **Cambridge Science Fair /South Shore Science Fair** held at the Quincy Center for Innovation every spring. The college students volunteer to teach students K – 12 and the community about bioscience topics, DNA, how drugs are made and how to keep a drug safe from contamination.

- Students provide guided lab tours for new students and visitors who attend the fall and spring **Quincy College Open House** events to provide the community with information about the program.
- A partnership with the **Boston Private Industry Council** includes participating in industry events that allow biotechnology companies to know what resources are available to them and enable biotechnology training programs to ask industry professionals specific questions relating to training and jobs.
- The partnership with the **Asia American Civic Association** supports students with an excellent ESL program and assists the BTC program in understanding and overcoming the challenges that international students often confront when applying and interviewing for jobs.
- **Bristol Plymouth Technical High School** has partnered with the BTC program since 2015. Their goal is to introduce their students to a manufacturing skill set. An articulation agreement is being developed between QC and Bristol Plymouth that will allow high school graduates to enter the Quincy College BTC program and transfer high school coursework that will count toward the Introduction to Biotechnology course (BTC101).
- For the past four years, the BTC program has fostered a working relationship with **Quincy High School's** biotechnology program. Students visit the Quincy College lab and work with college students to reinforce techniques learned in their program and to learn new techniques.
- Program Chair, Bruce Van Dyke and Dr. Joan Abrams, Biotechnology Instructor at **Cambridge Rindge Latin School- Rindge School of Technical Arts (RSTA)** are introducing RSTA high school students to biomanufacturing. Chair Van Dyke has presented biomanufacturing lessons and demonstrated equipment to RSTA students and the BTC program will host RSTA students in the BTC laboratory.
- Faculty members attend industry conferences and the program is a member of the **Massachusetts Biotechnology Council**. This robust industry partnership helps to ensure that the Quincy College curriculum is relevant to the skill demands within industry.

In December 2014, the program received a platinum endorsement from the Massachusetts Life Sciences Education Consortium (MLSEC), an initiative formed to facilitate partnerships between the life sciences industry and higher education in order to more effectively match graduating students with the jobs that companies are seeking to fill. The platinum rating highlights the Quincy College program's commitment to excellence, robust industry partnerships and job placement. The MLSEC has also awarded the program with grants: \$100,000 in 2013 and \$500,000 each year from 2014 – 2017.



The QC Biotechnology and Compliance Program has firmly established itself in a short period of time as a program of excellence in the industry in the Boston area. Shire has contracted twice with QC to provide training for incumbent workers. Industry partnerships, such as with Shire and Genzyme, have led to employment for graduates. Agilent Technologies installed ChemStation software for HPLC functions in the QC lab. A partnership with Biogen in Boston has been expanded to include the North Carolina branch with plans for proactive recruitment. Mass Biologics has developed a robust partnership with the program and talks are being held with JR Biotek about the possibility of online training to select African universities.

CONCLUSION

Student Success

Research Question: Middle-Skills Employment: Are students successful finding jobs in the industry? Do they remain employed at six months? At one year? At two years? As employees, are students promoted? Have they received a pay increase? Do they earn more money upon completion of the program than they earned when they began the program?



Daria, An A.S. Student

Daria came to the Biotechnology and Compliance Program in 2013. At the time her employment experiences had been as a hair dresser and she considered a career in nursing until she discovered the biotechnology and compliance program at Quincy College.

She began her A.S program in the fall semester as a full-time student and moved through the courses to complete within the recommended two-year period. She applied for an internship for the summer of 2014 and was awarded a spot with a summer research project with Randstad for Takeda Pharmaceuticals. The internship paid \$18.00 per hour. Following her internship, she was hired by Randstad as a “Contractor” in a full-time position beginning in September of 2014 at \$27.00 per hour. Daria worked in this position for two years and was then appointed to the position of “Research Associate” with Takeda Pharmaceuticals. She has been in this position since October 2016 is now a salaried employee paid \$65,000.00 per year plus bonuses.

Daria received two promotions in two years and salary raises that moved her from approximately \$38,000 per year to \$65,000 per year. Takeda invested in Daria as an intern and, seeing potential, hired her full time with a \$9.00 per hour raise. She received additional training from Takeda over the two-year period in which she worked as a contractor. Takeda now had even more invested in Daria. Her promotion to the position of “Research Associate” was a big step forward for both the company and for Daria.

Daria’s story illustrates the career trajectory of middle-skills employment. In technical biomanufacturing positions, companies invest in worker on-the-job training and seek to protect their investment through the development of career ladders. Proven employees have opportunities for pay raises, promotions, additional training and other benefits. While Daria’s rise may be faster than most, it is a powerful demonstration of the career opportunities offered in the middle-skills biomanufacturing industry. Daria is continuing her education at the Harvard Extension School to earn her Bachelor of Science degree.



Students completing the certificate and A.S. programs are successful in gaining employment. Table 18, “Employment in the Industry, Certificate and A.S. Graduates” displays, by year and by type of program the numbers of graduates who are employed in the industry.

Table 18: Employment in the Industry, Certificate and A.S. Graduates

Certificate Program	Year	Number Employed	A. S. Program	Year	Number Employed
-	2013	-	-	2013	-
12	2014	6	16	2014	14
22	2015	6	11	2015	8
16	2016	4	10	2016	7

Note: 2016 numbers are not complete

The difference between the numbers of students hired who completed the certificate program and those who completed the A.S. degree program is significant. Data indicate that the majority of certificate students do not gain employment in biotechnology.

Certificate students are a remarkably diverse group who are recruited and assessed by Jewish Vocational Services (JVS). Interested students complete a 23-week program at JVS and then are given a post assessment to determine if they are ready to enroll in the certificate program at Quincy College.

The BTC program, however, has found that some of these students are not well prepared in basic science and math concepts. Additionally, they often struggle with English, both written and conversational. Since proficiency in academic language typically lags behind the development of conversational language, academic success is at risk. Many of the students are immigrants and/or first generation college students with a limited sense and lack of models about how to be successful in college.

To learn more about some of the challenges faced by students, program completers from both the certificate and the A.S. programs were surveyed in October 2015 about their experiences and perceptions with the job application process. The Quincy College Institutional Research Office emailed the survey to all program completers via Survey Monkey. It was sent to 57 email addresses. Four emails bounced back and one student opted out of completing the survey. A total of twenty-three students returned the survey. Results demonstrated that many aspects of the job application process were daunting and that the overall process was perceived as difficult, particularly for the certificate students. Interviewing, completing paper applications and completing on-line job applications were specifically noted as troublesome. Table 19, “Student Perception of the Job Application Process” displays the results of the survey.

Table 19: Student Perception of the Job Application Process

SURVEY TOPIC		CERTIFICATE RESPONDENTS	A.S. RESPONDENTS
Perception of the Job Application Process	Easy	2	2
	Neutral	6	6
	Difficult	6	0
Specific Challenges	Interviewing	7	2
	Application Process	6	1
	Completing On-line	5	1

The Biotechnology and Compliance Program took immediate steps to address this issue. The Program Chair contacted the ESL Chair at Quincy College who made some valuable suggestions about English language testing and how to use tutors both before and after class. The BTC and ESL Programs are now working closely together to ensure that students are aware of resources and that best practice strategies are in place. Changes to the curriculum were also planned and put into place. The seminar classes now include resume preparation and mock interviews. The Program also began a Recruiter Night. This event hosts a panel of recruiters who discuss the process for hire. Students are able to ask questions and following the panel discussion, there are breakout sessions and opportunities for on-on-one interactions between recruiters and students.

In 2015, the BTC program learned of the Asian American Civic Association (AACA) through one of the Associate degree students who used their services when she first moved to Boston from China. This student attributed her success in English to the AACA and their excellent ESL programs. AACA is located in the Boston Chinatown neighborhood and Quincy College faculty and staff, during an on-site visit, discovered a rich resource for adults learning English, as well as a variety of support services including job training and college navigation services. The BTC program is working with senior administration to develop a Memorandum of Agreement with AACA to help the BTC program with English Second Language learners, job readiness training and job search skills in a cultural context. AACA has a Career Center that is free to the public.

Employment data for certificate students improved in 2016. While a trend cannot be determined from two years of data, the indications are positive. Long term data and information about pay increases are not yet available.

Research Question: Higher Education and Middle-skills Job Training: Are training programs viable? How can the resources to pay for state-of-the art equipment be earned? What conditions need to be in place?

The impact of the Biotechnology and Compliance Program on Quincy College has been positive. The five-year program review conducted by the Quincy College Program Review Committee concluded the following in 2015.

1. *Effectiveness of outcomes and goals: The Quincy College BTC Program maintains the integrity and intent of the stated outcomes and goals.*
2. *Community need: The Quincy College BTC Program is meeting the increasing industry needs.*
3. *Quality: The rigorous nature of the Quincy College BTC Program maintains the increasingly higher standards within the profession.*
4. *Productivity: The Quincy College BTC Program is at maximum capacity and proving its success.*
5. *Costs: Increases in student number and the addition of an evening cohort have allowed the program to become a profit center for the College.*

Despite this positive review, following the cessation of TAACCT grant funds, the program must find ways to pay for the lab costs, supplies and new equipment to ensure that graduates are trained in the most current methods and processes. Industry partnerships are a critical component of the sustainability plan. See, in this report, “Additional Findings. Partnership with Private Industry” for an extended discussion of partnerships and the critical role they play in sustainability. The BTC program faculty is being creative and resourceful as they explore and put into place a suite of plans to ensure their position as a preeminent biomanufacturing training program.

Non-credit Training

The BTC program offers non-credit “Incumbent Worker Training.” This training program is designed for current employees of a biomanufacturing company. For example, Shire sent 2 groups of employees (incumbent workers) to the Quincy College BTC program to be trained on the AKTA pure system, which is the protein purification equipment and the software that accompanies it. This is a new technology that biotechnology companies are beginning to purchase and use and their employees need training to become proficient.

Short courses include: ÄKTA pure, High Performance Liquid Chromatography (HPLC), and Gas Chromatography. The BTC program can also customize training for an employer needing to train their employees on specialized skills in biomanufacturing.

The short courses are usually offered 7 hours per day for 3 -4 consecutive days as needed. Non-credit training is also available for Laboratory Technicians, Manufacturing Technicians, Chromatograph Instructors, Quincy College personnel and chemistry and biology students. A schedule for training fees has been established: the industry rate is \$1500 per course; the researcher rate is \$1000; and the student rate is \$800. The program has a dedicated laboratory and 12 laptops for running the specialized software.

Virtual lab

Quincy College developed the virtual laboratory program through full funding (\$500,000) from the Department of Labor grant: <http://atelearning.com/qcbio/>. Interactive online modules and simulation-based virtual laboratories form the core of the system that includes online lessons, assessments, a glossary and supporting materials. The system design adapts and integrates cognitive information processing, systems analysis, and adult learning theories. It employs effective “learning-by-doing” and problem-based learning methodologies. Students process new knowledge and master complex operational and maintenance skills in such a way that it makes sense to them in their own frame of reference. Quincy College is the first college to integrate a comprehensive virtual learning environment into its biotechnology program. The laboratory prepares students to use the ‘real’ laboratory through virtual learning of fundamental laboratory processes for biology, biotechnology and biomanufacturing. It demonstrates biomanufacturing techniques such as tissue culture, aseptic techniques, and upstream processing (scale up from one milliliter vials to a 10L bioreactor).

The virtual lab is an open and free resource and can be used by high schools, training programs and industry to train employees in the upstream and downstream processes required for biomanufacturing. The BTC program will utilize the virtual lab in the development of an online program. The lab is accessible to any national and international group. The BTC program has been approached by a nonprofit international organization, JR Biotek, about a collaboration to provide biotechnology programs in Africa with online training. The African fledgling biotechnology programs lack adequate laboratory equipment

and skilled instructors. Organizations such as JR Biotek, as well as the Boston-based organization, Seeding Labs, are committed to helping Africa with donations of up-to-date laboratory equipment and supplies. Recently, Dr. Kingdom Kwapata of the University of Agriculture and Natural Resources in Malawi, Africa visited the lab facilities at Quincy College and expressed an interest in partnering. Partnerships would generate income for the program, as while the virtual lab is free for anyone to use, there would be a charge for training materials and classes provided by the Biotechnology and Compliance Program.

Products for Sale

In the spring of 2016, two representatives from the BTC program visited colleagues in Utah at Salt Lake Community College (SLCC) where a biotech program similar to the one at QC is offered. The SLCC has two initiatives in place that generate money to maintain their biotech program. The first, INNOVA, integrates industry and training through a research program in which students conduct research (with the guidance of faculty mentors) on matters that are of interest to the contracting company. A student might, for example, research the effectiveness of a medical device or a filter. The company pays the student. Students reported that these opportunities not only support them financially but that they also expand their knowledge bases. There is also a benefit to the program in that such projects serve to further develop the integration of industry and training and to promote a climate that generates more internships and post-graduation employment. The second program developed by SLCC to generate income is contract manufacturing called STUDENTFACTURED. One contract currently being filled at SLCC is the assembling of science kits for the public schools in Utah. Students collect the needed items and put the kits together. The entity contracting with the Program pays the Program directly.

The QC program is considering how to replicate these ideas within the Boston context. They are also thinking about the sale of a by-product, myoglobin that is produced in the lab during the manufacturing process. A company has expressed an interest in buying the myoglobin at \$1,000.00 per milligram for research purposes. Entrepreneurial efforts will be continued to be explored as one avenue to promote sustainability.

Higher Ed Accommodations

Another important element of sustainability is the willingness of Quincy College to accommodate the unique needs of a state-of-the art technology training program. For example, colleges tend to be tied to semester and class schedules that are not necessarily compatible with the schedules of employed students who are seeking training for better jobs. Colleges tend to prioritize student credit hour production and numbers of graduates while training programs, such as biotechnology, require smaller class sizes so that hands-on lab experiences are conducted appropriately. Also, college programs that may be supported financially by local industry may find it difficult to access funds from central accounting. The BTC program, for example, has provided incumbent worker training to a local pharmaceutical company and hopes to do more of that type of training. Establishing a cost center for the program (or department) would ease access to funds and encourage further entrepreneurial efforts on the part of program faculty.

Quincy College has demonstrated a willingness to work with the Biotechnology and Compliance Program. The nine-month certificate program is not scheduled to coincide with the QC semester schedule but is able to be offered on an ‘off’ schedule basis. Also, a change to accounting practices was recently approved that will allow the BTC Program to more easily access the funds that they bring in or that are donated by industry. These accommodations are important signs of recognition by the Quincy College administration that worker-training programs may need to be administered differently than the traditional liberal arts majors.

The Biotechnology and Compliance Program is positioned to establish its reputation as the premier player in biotechnology in the Greater Boston area. In order to do so, the Program must be supported to engage in advertising, recruitment of students, and entrepreneurial activities that support the expenses of lab supplies and equipment. Biomanufacturing is a dynamic industry and a successful training program must have the agility to mirror those dynamics. While it can be challenging to modify established college practices and procedures, Quincy College has recognized the need to accommodate the BTC program. The Biotechnology and Compliance Program is a model for middle-skills job training programs located in a higher education environment.

NEXT STEPS

What are some next steps based on the results?

1. A continuation of entrepreneurial efforts to ensure the BTC's place as state-of-the art worker training. A significant challenge for middle-skills worker training programs is to be able to keep up with the dynamics of a rapidly changing industry such as biomanufacturing. The Quincy College BTC Program, with the support of Quincy College, is ready to demonstrate how to do so.
2. Supports for the certificate students will be put into place. Data and descriptions regarding the effectiveness of these supports will inform other middle-skills training programs. The demographics of the diverse BTC certificate student population, i.e., first generation college students, English as second language speakers, multiple ethnicities, etc. present challenges for higher education but also represent a population that will benefit greatly from middle-skills job training.
3. Expanding the student population to include educated workers who are underemployed or who seek new opportunities. Recruitment of students who have some college or who have completed four-year degree programs may be a new population for the BTC program. A 'fast track' certificate for such students is under consideration by the BTC faculty.

The Quincy College five-year program review committee concluded in 2015.

Overall, the Biotechnology and Compliance program is in good-standing according to the Massachusetts LifeSciences Education Consortium (MLSEC), an initiative formed to facilitate partnerships between the life sciences industry and higher education in order to more effectively match graduating students with the jobs companies are seeking to fill. In December 2014, the program received a platinum endorsement from the MLSEC. The platinum rating highlights the commitment for program excellence, robust industry partnerships and job placement. There is a high-degree of student and industry interest; retention in the program is good; Associate degree graduates gain employment upon completion of the program; the laboratory equipment and the hands-on learning aspect of the program have led to a positive impression of the program among community stakeholders (e.g. MassBio Education Council, Boston Private Industry Council, Jewish Vocational Services and program affiliates) and industry partners.

The Quincy College Biotechnology Program has used the opportunities provided by the Department of Labor TAACCT grant to remarkable advantage. The certificate and A.S. degree programs are in place and graduating students are hired in the industry. The lab is

widely viewed as state-of-the art and the virtual lab literally opens up a world of possibilities. Networking efforts have been broad and deep and private industry partners are engaged, active and contributing members to the program.

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