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Jeffery Bowen

Bridgewater State College, jabowen@bridgew.edu

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BSC CityLab: Teaching Tomorrow's Technology to Today's Youth

by Jefferey Bowen



HISTORY OF BSC CITYLAB

For the past decade, BSC CityLab has provided exciting and authentic science laboratory experiences for students in Grades 5–12 through classroom visits, lending labs, and summer programs.

Additionally, many professional development opportunities exist through BSC CityLab for science teachers in southeastern Massachusetts to provide them with much needed background and experience in the field of Biotechnology. BSC CityLab began as a satellite of Boston University School of Medicine's CityLab (BUSM CityLab). As part of its mission, BSC CityLab promotes and supports STEM (Science, Technology, Engineering, and Math) partnership activities to strengthen pedagogy for pre- and in-service teachers and to improve outcomes and increase science enthusiasm among students.

In the fall of 2000, the faculty associated with BSC CityLab received an \$800,000 Science Education Partnership Award from the National Center for Research Resources of the National Institutes of Health, a division of the Department of Health and Human Services (Drs. Michael Carson and John Jahoda were Principle Investigators on this grant). Science Education Partnership Awards (SEPA) are designed to improve life science literacy throughout the nation. These grants promote partnerships between biomedical and behavioral researchers, educators, community groups, and other interested organizations to create and disseminate programs that give K-12 students and teachers and the general public a better understanding of life sciences. In short, SEPA grants promote the ideals that BSC CityLab also promotes and the SEPA grant provided BSC CityLab the help it needed to grow and develop.

During this granting period (beginning in the Fall of 2000), BSC CityLab expanded from an initial partnership with two school districts, Brockton Public Schools and Bridgewater-Raynham Regional School District, to one serving more than twenty school districts in southeastern New England. In the academic year 2003-2004, approximately 1800 students participated at BSC CityLab in highly engaging hands-on science modules



that follow a "progression of inquiry" model that was originally developed at BUSM CityLab.

Another 500 students received an authentic CityLab experience in their classrooms using a BSC CityLab Lending Lab with their CityLab-trained teachers. In-service and pre-service teachers enroll in graduate level courses in science content related to biomedicine and biotechnology, and are trained in the CityLab curriculum and pedagogy including Lending Labs. Faculty associated with BSC CityLab have also led more than fifteen workshops or presentations for educators at various Regional and National conferences and have helped to develop new inquiry-based modules.

Below, an example of one of the programs run at BSC CityLab is described. In this case, it is the summer biotechnology program called Whale of a Mystery designed to engage students entering sixth through ninth grades. As with all of the programs offered through BSC CityLab, the purpose is to help students make connections with the use of inquiry-based strategies that incorporate hands-on activities in a manner that builds student knowledge and confidence.

WHALE OF A MYSTERY

Imagine you are a newly hired scientist working for the Bridgewater Animal Forensic Laboratory (affectionately known as BAFL) located on the third floor of the prestigious Moakley Center at Bridgewater State College. It is your first day of "work." So far, the morning has been quite busy with new employee orientation where you heard about the history of the company, filled out some new employee information, and received a laboratory notebook...standard stuff! It became a lot more exciting when Dr. Mike (one of the Senior Scientists) told everybody of the infamous case that BAFL solved that revolved around a canine celebrity that was "dog-napped" and disguised as a toy poodle (the courts have placed a gag order on the specifics of the case) and how using a "protein fingerprint" helped to break the case open. Even though you were nervous at first, you feel that this is a positive working environment, a good company, and they clearly need your help.

After the orientation, you and twenty-three other new employees move into the laboratory to begin your training. The lab looks very high-tech with all of its equipment and instrumentation along with their strange names; things like microcentrifuge, pipetteman, and a gel electrophoresis apparatus. This place looks exciting and you are glad that you were hired for this week-long special assignment.

The new hires, or Junior Scientists as you're called, break up into teams of three to begin the process of learning how to use the equipment. The Senior Scientists are busy explaining how the equipment is used, and since the equipment is like nothing you have ever used before, you are glad to have some help with learning how to use it properly. You notice that each team has a team name. Suddenly, it dawns on you that you recognize the names...they are famous scientists! You are proud to be on Team Watson, named for one of the scientists that discovered the three-dimensional shape of DNA.

Then something strange happens. As you and your team are learning to use the pipetteman, a device used to measure very small volumes of liquids, you noticed that the lab became quite busy with activity. This was shortly after a phone call that Dr. Mike received about some packages that were just delivered to the front desk. You know this because Dr. Mike asked Dr. Pat and Dr. Meri (two other Senior Scientists) to pick up the packages. They return with a cart full of boxes and every box is marked "Evidence." Dr. Mike called a meeting with some of the Senior Scientists while everybody went on break.

Upon returning from break, Dr. Mike explains to Junior and Senior Scientists that the boxes are evidence from a very important and ongoing case that BAFL has been investigating. He goes on to explain that the boxes of evidence came from one of BAFL's field agents, a scientific sleuth named Jonah Cetacean. Jonah and the rest of BAFL have been investigating the illegal capture and sale of whale meat in seaports and fish markets around the world. Jonah has recently obtained samples that need to be verified as to whether they are whale meat and, if so, to which species of whale they belong. Not only did Jonah send along some important information on the history of whaling and the different types of whale species, he also asked the team to go to Stellwagen Bank National Marine Sanctuary to look for whales and report back any sightings.

Dr. Mike seemed worried that the training was cut short by the arrival of the important case, but you and the rest of the Junior Scientists convince him that you are ready! To facilitate training of protein fingerprint-

ing, everybody breaks up into Expert Groups. There are three Expert Groups with one Junior Scientist from each team. The Expert Groups are to take a crash course in a particular technique and then bring it back to the team and train the other members. You found that this approach works very well, especially since you are the Gel Loading expert!

Wow! What a first day of work and it's only lunch time! Throughout lunch, there were all sorts of rumors and speculations flying around. The one that was the most intriguing was that BAFL and their scientists may be subpoenaed to testify before a Congressional Hearing on Endangered Species. While you hope that you don't get subpoenaed, you would like to help and it would be interesting!

Now that you and your team have enough training, you are ready to begin collecting data for the case when you return from lunch. Jonah is a well-trained field operative and, as such, knows which samples are the best for protein fingerprinting and how to prepare them for future study. With that being said, you didn't expect any problems. Fortunately, there are eight evidence boxes and eight teams. Your team retrieves its designated evidence box and you begin your observations of the sample. However, there seems to be a major problem! It appears that Jonah placed three samples into each evidence box. He did, however, mark each sample as A, B, or C. The problem is that when he packed the samples in ice to send them, the paper identifying each sample got wet and you can't read it any more. This is a major problem since you need a piece of muscle tissue which contains a lot of protein to run the protein fingerprint. Gross observations of the samples indicate that all three samples in your box look like they are different, but you don't know what each sample is. As it turns out, all the other teams are having the same problem...the Senior Scientists will need to talk to Jonah about this.

It is now time for a brainstorming session with all the scientists to figure out how to determine which sample is muscle, or whether they all muscle. As a company, you figure out that tissues taken from different organs, like muscle or liver, are going to look different under the microscope. If you look at the cellular arrangement of the different tissues, then maybe you can determine the organ of origin for each sample. Sure enough, by the end of the first day, you know which sample is muscle and you can begin the process of protein fingerprinting the next day. It looks like tomorrow will be just as busy as today, but you hope that there are no more unexpected bumps in the road!

SCIENCE SUMMER PROGRAMS

This is only the first day of a week-long program that includes hands-on scientific activities, a whale-watch, and a presentation to a “mock” congressional hearing along with a few other unexpected events along the way. Feedback from students participating in Whale of a Mystery and their parents has been very positive. As with all of our CityLab modules, Whale of a Mystery involves critical thinking, math, and language arts skills. Critical thinking skills are a hallmark of all CityLab modules and are integrated throughout the experience with twists and turns throughout the storyline beginning with the engagement piece. Math skills are promoted by graphing and analyzing the collected data. Language art skills are encouraged through writing in lab notebooks, contributing to Reflections (a BAFL newsletter composed of articles and artwork by the Junior Scientists), and preparing for the poster presentation given on Friday by each team to the mock congressional hearing. Additionally, the students are doing real science and using real biotechnology equipment to help them solve a problem.

In addition to the inquiry-based scenario adapted by the summer programs, another great advantage to this program is the outstanding help of Bridgewater State College faculty, staff, and students. The faculty that work on this summer program include four Biology professors (Drs. Jeff Bowen, Michael Carson, Merideth Krevosky, and Patricia Mancini), a Chemistry professor (Dr. Frank Gorga) as well as an English professor who plays the role of our company lawyer and helps the students to prepare their testimony (Dr. Anne Doyle) in addition to the Program Coordinator (Ms. Cathy Hart, BSC '02). The program also enlists three or four undergraduate students who are interested in a career in teaching. The high instructor to student ratio works very well and the students get a chance to work with real scientists and professors. Additionally, the students, most of whom are female, get to see the huge role that women can have in science and the women who work with BSC CityLab are outstanding role models for these students.



Left.
Dr. Merideth Krevosky
(Assist. Professor, Biology
Dept.) demonstrates to
teachers how to set up some
biotechnology equipment
during a teacher workshop
at the Museum of Science.

Below,
Two students participating
in solving “Lab Larceny”
during a visit to BSC CityLab.



The interaction between the “Senior Scientists” and the students is critical in our summer programs as is also evident in our high school level summer program called Thread of Evidence. In Thread of Evidence, students run the Forensics Institute at Bridgewater (or FIB, as we like to call it) and need to use biotechnology to solve a case of industrial espionage and kidnapping that occurs within the company when one of the Senior Scientists turns up missing and there is evidence of foul play. Since high school students tend to be a little skeptical of stories like this, we are upfront that we are playing a game such as a murder-mystery dinner and they are welcome to play along with us. As long as we are upfront with the students that we are not trying to convince them that this is a real situation, they invest themselves in the story. As the program moves forward, rumors and accusations run rampant as the students use DNA evidence and other biotechniques at their disposal to lead them to the primary suspect...another Senior Scientist.

The students have to prepare their evidence and present a hypothetical version of what happened on the evening the scientist disappeared.

CLASSROOM VISITATIONS

All of our modules, be it for week-long programs like Whale of a Mystery and Thread of Evidence or for one-day experiences for local schools, are based on a case or mystery that students have to solve. The modules that are offered in one-day experiences include a pre-laboratory exercise that is done in the classroom to provide the background and the mystery that needs to be solved. As with the summer program, the storylines are designed to be open-ended to help the students “discover” the best way to solve the problem. The only way to solve these mysteries is to use modern biotechnology. The lab equipment is only there to help find an answer, not the other way around.

The most popular module is The Mystery of the Crooked Cell that was originally developed at BUSM CityLab. This module for middle school aged students explores sickle cell syndrome with the progression-of-inquiry approach. Students begin with a description of a patient with symptoms of some sort of malady. Through a series of inquiry-based and hands-on steps, they can determine that the disorder is indeed sickle cell syndrome. After obtaining a “sample” of the patient’s blood, they perform a series of tests to definitively prove their hypothesis...case solved!

For high school students, BSC CityLab has developed “Chances Are?,” a follow-up to the middle-school module based on sickle cell syndrome described above. In this module, high school students play the role of genetic counselors and learn how to correctly develop and analyze a pedigree, decide which family member(s) should be tested, and use polyacrylamide electrophoresis to run the diagnostic test. In addition to the biotechnology needed for this module, students must also face and discuss some of the ethical dilemmas people face surrounding the knowledge that can be garnered from knowing your genetic make-up.

TEACHER TRAINING & LENDING LAB

BSC CityLab has historically been very involved in providing opportunities for pre- and in-service teachers through courses in support of the Masters of Art in Teaching program and workshops throughout southeastern Massachusetts. The courses that the faculty offer serve two major functions. The first is to provide area teachers with content knowledge in the area of Biomedicine and Biotechnology that they can take back to the classroom and expand the teachers’ knowledge base. The second major function is to provide teachers with alternative pedagogical strategies that they can

use in their classrooms and the training to become proficient in the techniques associated with the modules.

Once teachers are trained, they will be able to borrow equipment, supplies, and reagents to take back to their classroom through BSC CityLab’s Lending Lab program. Efforts are currently being put forth by BSC CityLab to expand the Lending Lab program. Although we recognize the intrinsic value of having area students come to Bridgewater State College and BSC CityLab, we also realize that many school districts are facing financial difficulties and cannot absorb the cost of a substitute teacher and busing required for a BSC CityLab visit. Many of the modules that are run in BSC CityLab have been modified to work in a classroom with the time and space constraints that teachers face.

FUTURE OF BSC CITYLAB

Unfortunately, federal and grant moneys are sparse for programs that are designed for children and the programs and grants that do support such activities are very highly competitive. BSC CityLab was fortunate to receive the seed money from the SEPA grant. However, for BSC CityLab to continue, we must get BSC CityLab institutionalized and create an endowment for the continued development and running of our modules and programs. To this end, BSC CityLab is continuing to pursue granting opportunities and has begun a campaign to raise the finances to keep this outstanding program going. Additionally, BSC CityLab is working to become formalized as an established center on campus that would provide the basic infrastructure and necessities to run the programs. If you are interested and would like to help BSC CityLab educate our children in the uses and applications of science, especially biotechnology, please feel free to contact us at CITYLAB@bridgew.edu or you may contact the director of BSC CityLab, Dr. Michael Carson (mjcarson@bridgew.edu).

—Jefferey Bowen is Associate Professor of Biology.