AC 2007-2219: STUDENT/TEACHER TEAM BIOTECHNOLOGY/GENETICS WORKSHOP

Virgil Cox, Gaston College

Virgil G. Cox, OE , Dean of Engineering and Industrial Technologies at Gaston College for almost twenty years Dean Cox has taught courses in a broad range of engineering disciplines, has evaluated many programs and courses and published over 10 articles dealing with technology and education in refereed journals. Dean Cox was also an Associate Professor of Ocean Engineering at Maine Maritime Academy. Dean Cox is a retiree of the US Navy and a Veteran. Dean Cox received his B.S., MSEE, and Ocean Engineers degrees from the Massachusetts Institute of Technology.

Mary Beth Ross, Gaston College

Mary Beth Ross earned a Ph.D. in English from Syracuse University and undertook post-doctoral work in linguistics at University College London. She has over twenty years experience in higher education as a classroom teacher and curriculum developer (Syracuse University, S.U.N.Y. Utica/Rome, The Women's Writer's Center, and Philander Smith College). Currently serving as the director of grants and special projects at Gaston College, she previously spent nearly a decade with The National Faculty, planning and implementing K-12 teacher summer workshops like this one from Alaska and Hawaii to Louisiana and Arkansas. This was the first time she was involved with one that included students. She is working with various faculty members and administrators at Gaston College to seek additional grant funding to repeat this project and extend this model to other subject areas.

Phyllis EssexFraser, Gaston College

Phyllis Essex-Fraser received an MSc in Zoology (Molecular Physiology) from the University of Guelph, Guelph, Ontario, Canada in 2003. That same year, she began teaching in the Science Department at Gaston College. In addition to her teaching duties, she has developed core, transferable courses for Gaston College's AAS in Biotechnology, participated in the development of the curriculum for a week-long workshop in Biotechnology for regional community college Faculty (2006) and in its facilitation, independently developed the curriculum for the NSF Diversity in Education Workshop (2006) and independently facilitated it, published a scientific research paper in the Journal of Biological Chemistry (2005), participated in the development of numerous grant proposals at Gaston College, as well as having published several scientific, educational manuals. Ms. Essex-Fraser continues to develop her own educational and scientific skills and abilities, and is a current member of the Gaston College, North Carolina, and National Associations of Educators.

Student/Teacher Team Biotechnology/Genetics Workshop

Abstract

Cognitive and metacognitive theories regarding learning and teaching emphasize experience and feedback. Combining these techniques in STEM education and teacher professional development is not easy to accomplish. A unique format for delivering science content, teaching lab technique, and providing science teachers with a teaching professional development experience was piloted as part of an NSF diversity in engineering technology grant. A one-week workshop on biotechnology and genetics was created. This paper presents a summary of techniques, participant evaluations, and an overview of planned activities. Sample lab and lecture materials can be obtained from the author. The attendees were high school biology teachers along with one student selected by each teacher to create a learning team. The science and lab technique was new to both the teachers and the students. The team's goal was to maximize learning. The pair helped each other understand the lecture material and conduct the lab exercises. In-class activities included lecture, lab exercises, media presentations, inter-team discussions, general discussions, study sessions, projects, social events, and team final presentations. These activities created an environment in which the teacher could: learn new science content and lab techniques, directly observe a student learning the same material. This workshop provided opportunities for the teachers to engage in collaborative learning and engage in inquiry-based learning. At the end of each day the science teachers met separately for a debriefing session with the high school science administrators (county level science coordinators). Data were collected by the workshop administrators for evaluation. The teacher's overall satisfaction rating (OSR) of the workshop was 3.94 out of a possible 4.0. The student OSR was 3.91 out of a possible 4.0. The technique has shown value in simultaneously expanding science teacher's knowledge and teaching skills and interesting students in STEM careers. The high school administrators and teachers were so impressed with the results of this technique that twice as many science workshops are already scheduled for next summer. The technique is also being expanded to engineering fields.

Background

The National Science Foundation funded a grant entitled "Diversity in Engineering Technology Education". The grant's principle investigator was Dr. Stephen Kuyeth in the Engineering Technology (ET) Department of the University of North Carolina at Charlotte (UNCC). The grant created a venue in which the ET department coordinated with regional community colleges and high schools to create a tiered team to conduct activities designed to increase high school student's interest in science, technology, engineering, and mathematics (STEM) and engineering technology. Some of the activities included inter and intra school competitions with robots, trebuchets, and school team performance on the annual Junior Engineering and Technology (JETs) exam. The community colleges worked with the high schools in their service areas to provide mentoring and guidance for both the students and the teachers (few of whom knew much about the JETs exam or building robots, etc.). The author and the author's school participated in these activities.

During this same time period the author's school received a Duke Energy Foundation grant that created a state-of-the-science biotechnology/genetics laboratory. Also, a major regional interest in creating the infrastructure for the biotechnology industry was growing. Therefore the author proposed and was funded to conduct a unique workshop for high school students and high school technology/science teachers in the college's service area. The weeklong workshop was taught by a teacher from the college's science department, Phyllis EssexFraser, and had as its purpose to introduce biotechnology/genetics techniques into the science curriculum in the areas high schools, provide the high school participants with knowledge and skills from the biotechnology field, provide the high school teachers with professional development and "take-home" materials, and encourage more students to pursue careers at the crossroads between science and technology. The out-of-lab parts of the workshop were designed, coordinated, conducted, administered, and directed by Mary Beth Ross The workshop also had the purpose of piloting a new learning-team concept to be described below.

Theory and Literature Review

Many techniques are used by teachers to "teach" students and teach teachers to teach. Research by Mathan, and Koedinger⁽¹⁾ and independently by Mok, Lung, Cheng, Cheung, and Ng⁽²⁾ report on cognitive and metacognitive feedback being useful in these teaching processes. Many teaching techniques employ techniques such as learning teams, learning camps, lecture and labs, one on one (teacher and student), feedback, discussion, teacher professional development workshops, conferences, etc.⁽³⁾ However, the author has not found documentation of a technique that duplicates the one described in this paper, i.e., the use of one student and one teacher functioning as a learning team.

Description of the workshop

This workshop incorporated many techniques delineated above to reach its learning goals and publicly stated goals. To meet the science content and lab technique goals, the workshop instructor created a biotechnology/genetics program and created a series of presentations/demonstrations along with lab exercises that re-enforced her presentation material. She also created a lab manual for the students and another lab manual for the high school teachers. The teacher's professional development included exposure to new materials and lab techniques but also involved the creation of student/teacher learning teams. Each teacher who participated was also required to bring a student from their school that could benefit from the workshop. A sample day is displayed below

8:30 -	Introductions
9:15 am	Syllabus Review Lab Safety/Orientation
9:15 -	Genetics: A Timeline
9:45 -	DNA: The Secret of Life (DVD)
10:30 -	Break
10:45 -	Gregor Mendel: The Father of Genetics
11:30 -	Mendelian Terminology
12: 00 -	Lunch
1:00 -	Pre-Lab: Monohybrid Crosses & Punnett Squares
1:30 -	Lab: Monohybrid Crosses & Punnett Squares

2:30 -	Break
2: 45 -	Lab: Monohybrid Crosses & Punnett Squares Completion
3: 30	Student Departure Teacher Evaluation/Consultation
4: 30 pm	Depart

The workshop incorporated a big kick-off and a final banquet with important guests and a guest speaker (well known in the biotech industry as well as in education). Lunch periods and breaks had exercises that supplemented and complemented the presentations and labs. Teachers and students all had stipends to defray the travel costs. T-shirts with a DNA chain and appropriate logos etc. were provided. Students/teachers had some “homework” to accomplish. All-in-all it was a well designed fun/content/skill workshop. So, what was different?

Unique aspects of the workshop

There are several unique aspects of the workshop. From the point of view of the students this was similar to a tutoring experience since following the presentation/demonstration of the workshop instructor the student and the teacher had a “team” discussion to ensure that both of them had a thorough understanding of the material or the lab technique that had been presented⁽¹⁾. That experience is similar to tutoring except that the student was potentially as informed as the “teacher”. Additionally, as the workshop teacher and the participating teachers “discussed” things, the student was able to observe learned professional intercourse. That is similar to attending a professional conference. All of this happened every day and in every module.

From the point of view of the participating teacher there was new science and lab technique (and a lab manual to take back to school!). That could have been done in a teachers only workshop. What is unique is the team discussion that followed the workshop presentations. The teacher was now in an “almost” mentoring mode. Usually that meant that the teacher was the “expert” with all the power that came with having special knowledge. That was no longer the case. Though the teacher probably had greater learning performance skills than the student they were both dealing with NEW information. The teacher could directly observe the difference between her/his personal experience (and learning) and that of the student! The teacher had to create strategies to ensure that the “team” had a common base and that the team’s learning was maximized⁽²⁾. To quote one teacher “working with the students was great! – teachers had to be more professional and focused in order to help the students.”

Additionally for the teachers, at the end of each day, after the students had departed, a debriefing session was held. They shared significant experiences and discussed technique as well as the science of the day. The science coordinators of the two school systems attended these sessions. The most significant quote was “we need lots of curriculum based staff development.”

The third, but not totally unique aspect of this workshop was that, as a marketing tool, (i.e., getting the word out about STEM) this workshop put two people back in each school. One who had credibility with the teachers and administration and one who had peer credibility with other students. Though it is not possible to parse out the direct effect of this workshop on the increase in high school student interest in this college’s STEM courses, student comments indicate that it contributed.

It is also worth noting that the use of community colleges for teacher professional development in this state is rare. Several such projects are being funded this year.

Assessment

Below are some of the results of the end-of-workshop questionnaire. Comments regarding the performance of the workshop instructor have been removed but you can be assured that we were all thrilled with her performance. It is clear that the experience (which took place during student and teacher vacation time) was considered to be worthwhile.

Student Evaluation Summary

Students were asked to agree or disagree with the following statements on a 4.0 scale.

1	The material covered in this workshop was interesting	3.84
2.	The amount of material covered in this workshop was fair and reasonable	3.33
3.	The level of difficulty of material covered in this workshop was fair and reasonable	3.5
4.	Participants in this workshop engaged in meaningful discussions with the instructor	3.16
5.	Participants in this workshop engaged in meaningful discussions with one another	3.33
6.	The instructor was a knowledgeable and articulate lecturer	3.84
7.	The instructor was an effective guide in hands-on work	3.84
8.	The instructor effectively used instructional tools, resources, or media	4.0
9.	The instructor encouraged and responded appropriately to feedback from the participants	3.66
10.	The instructor's presentations were well-organized and carefully prepared	3.84

Open ended questions were also used and some responses are displayed below:
 Students were asked to describe the most important things they learned in this workshop. Responses were: The most important thing that I learned would have to be how to use various scientific equipment and what they are used for; DNA analyzing is not like on TV—it's work; the use of micropipettes, important issues on bioethics, electrophoresis; I found the skills (lab procedures) to be the most valuable thing I learned [and] I also gained valuable understanding of important basic biological procedures; how to safely and accurately use lab equipment [also] all the labs we did were important [and] I learned the importance of biotechnology in life; I learned more about DNA & extended my knowledge on genetics—I learned the interesting process of gel staining & de-staining [and] I also learned how to use a micropipette, which will come in handy for me in the near future.

What were the most important insights, information, or ideas you that will take from this workshop?

Responses were: Because of this workshop, I have a new interest in biology and hopefully can pursue a career in biology—I also learned about all the equipment that is used in biology and how important it is to be precise with everything you do; I will take the experience of working with my DNA and all the expensive equipment to look at life differently; most important was just the experience I gained from hands-on labs and information learned through the whole workshop; this workshop has given me a previously non-existent interest in biological technology [and] it has also inspired me to investigate further [study in] this field (perhaps even as part of a career) [and] it has taught me a lot about something which I had previously not known a lot about; I learned a lot of helpful information from the video clips and lectures [and] I thought it was all important because biotechnology and bioethics is a part of every-day life; the controversy over stem cell research, how DNA works—it amazed me how such little molecules could control a body as complex as ours—just the basic elements of genetics grasps my attention. What material covered in this workshop would you like to study further?

Responses were: I would like to learn more about DNA and how to use that information to help others; genetics; I would like to go more into gel electrophoresis and make more than two gels; I found the majority of the material covered in the workshop to be very interesting and more than worthy of further study [but] the most interesting thing is the RNA; I found that learning about genetics was interesting [and] I liked the DNA labs, but I don't think that it is something I could do every day [but] I think it would be neat to find a cure for some kind of disease or disorder; stem cell research and the controversy behind it—I would also like to extend my knowledge about the Human Genome Project.

Teacher Evaluation Summary

Teachers were asked whether they strongly agreed, agreed, disagreed, or strongly disagreed on a 4.0 point scale with statements regarding usefulness for their teaching, meaningfulness of discussions, etc.

The material covered in this workshop was interesting	4.0
The material covered in this workshop will be useful in my teaching	4.0
The amount of material covered in this workshop was fair and reasonable	4.0
The level of difficulty of material covered in this workshop was fair and reasonable	3.84
Participants in this workshop engaged in meaningful discussions with the instructor	3.84
Participants in this workshop engaged in meaningful discussions with one another	3.84
This workshop provided opportunities to engage in hands-on exercises	4.0
This workshop provided opportunities to engage in collaborative learning	4.0
This workshop provided opportunities to engage in inquiry-based learning	3.66

Teachers were also asked open ended questions and some of their responses are displayed below:

Describe the most important things learned in this workshop. Responses were: Laboratory technique and safety; student behavior in lab setting; the interaction between myself as a teacher and my student partner was great—it allowed the lab to be done in a “real world” classroom situation; lab techniques for micropipetting and gel electrophoresis; the basic laboratory procedures were extremely important to the students—it was also great that the students were able to use these procedures and apply them to actual biotechnology practice; working with the students was great!—teachers had to be more professional and focused in order to help the students; ways to include more hands-on activities/labs in class.

Teachers were asked to suggest any way the workshop could be improved. Responses were: Pre-learning activity for Hardy Weinberg—students have no background—schools could do this [although] it is not a strong part of current EOC tested biology curriculum; no response; I would like to bring a team of students to do the labs (2-3); I do not feel improvement is necessary for this workshop; please! have continuations of the workshops every summer or mini-workshops throughout the school year; include more labs that can be done with materials/supplies we actually have in public schools.

What were the most important insights, information, or ideas you that will take from this workshop? Responses were: Laboratory protocol and experience using lab equipment; great links for classroom use—all videos, DNA research, etc.; online resources; in addition to the exercises in class we also received information about how to perform other exercises with “everyday” materials—also, learning how to use the equipment; students can handle the materials—it has motivated me to find ways to incorporate this into my classroom; extracting DNA, part on population genetics (web site), corn activity.

What were the most important insights, information, or ideas that you will take from the daily wrap-up sessions? Responses were: What lab supplies/equipment I need to try to obtain; teacher connections, ideas, resources—pooling of resources between counties; how we could use the material in our classrooms—also the fact that we need lots of curriculum based staff development and that we’ll continue to look for opportunities; knowledge of certifications available at your school and possibility of future workshops; good way to debrief the day; biotech program information.

What additional professional development workshops would you like to have offered? Responses were: Teacher/student certification program; a continuation of this workshop next summer—maybe a phase II; workshops where the teacher leaves with all the knowledge and resources to carry out the experiment in class; any that deal with subject/curriculum based activities—possibly something where teachers get together and share labs; have follow-up sessions next summer or during the school year; general biology labs (we need to raise our bio EOC scores)—general chemistry labs.

Results

Students and teachers were both given an opportunity to increase their knowledge and skill in a significant rather new field (biotechnology and genetics) and teachers could additionally improve their teaching skills. One of the most significant events was when each team made a presentation on the last day on the topic “Ethics in Biotechnology”. Students and teachers were discussing ethical issues using concepts and language they did not know a week

prior. Changes in attitude and openness to new ideas is also testified to in the comments. One of the students who now is the recipient of a full academic scholarship at a state university told a journalist that the workshop was the most significant experience in her high school education. (Most of the students will not graduate until the end of the spring semester, 2007.) The technique and workshop paradigm are being adapted to more engineering and engineering technology oriented topics including physics and engineering presentations and labs. Follow-ups with the teachers and students are scheduled for summer 2007.

References

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