Collaborative Project to Enhance High School Science Curricula

C. P. Cotton[1], C. P. Harned[1], A. Shaw[1] and W. Waller[2]

[1] University of Maryland Eastern Shore Princess Anne, MD 21853 [2] Wicomico County Public Schools, Salisbury, MD 21801

Abstract

A capacity building project entitled "Collaboration with Secondary Education to Enhance Agricultural Science Curricula" was funded in 2007. A team approach has been used to incorporate agricultural concepts and applications into high school science curricula to broaden students' awareness of the extensive nature and diversity of the food and agricultural sciences. During summer 2009, University of Maryland Eastern Shore (UMES) collaborated with two teachers from Parkside High School in Salisbury, Maryland, to develop instructional units on drinking water quality and the interactions of species and organisms within their environment. One unit incorporates hands-on activities that educate students about the origin of their drinking water, biological contaminants that can cause health concerns, and ways to protect and conserve their drinking water. The second unit encompasses a variety of experiential learning activities and multimedia to capture student attention, and engage students to consider the requirements of life that are provided through symbiosis and biodiversity and relate them to symbiosis. The teachers worked closely with agriculture research faculty, content specialists, and a curriculum specialist to plan and develop their units. The technology liaison worked with the teachers to develop large format materials to support the project. By the end of July 2009, each teacher had developed a three to four week instructional unit that includes hands on experiments to be used by students. During 2009-2010, the units were pilot tested and initial results indicate that the experiential activities were considered very beneficial and student learning was enhanced.

Introduction

Partnerships with K-12 institutions that provide a mechanism for a smooth transition from high school to post-secondary education are of great importance at the University of Maryland Eastern Shore (UMES). Often, high school educators need an opportunity to update their content knowledge and re-acquaint themselves with college programs to be able to better prepare their students for the expectations in post-secondary education. This project seeks to expose students to agricultural sciences by bridging the gap between high schools and universities through the development of instructional units that reveal the connection between science and agriculture. These units will enhance course instruction, create relevance to the subject matter studied, and demonstrate how agriculture is an applied science, and more than just production agriculture. UMES' School of Agricultural and Natural Sciences (SANS) has the interest, expertise and facilities to collaborate with teachers to develop instructional units, to prepare instruction for delivery through a variety of media, and to package the units for dissemination through county- or state-wide professional development initiatives. This project is designed to build upon the synergy created by individuals from different disciplines and backgrounds working together to enhance science and agricultural sciences curricula. Family and consumer sciences, agriculture, and science teachers are given the opportunity to enhance their course instruction through the development of engaging, hands-on instructional units that provide relevance to the subject matter being studied. The participating teachers in the program also have the opportunity (1) to be exposed to the UMES agricultural programs; (2) to collaborate with university faculty; (3) to utilize university technology and facilities; and (4) to present and distribute the instructional units to colleagues at professional development workshops.

Methods

- During the 2009 summer program, UMES faculty, a secondary education curriculum specialist, and a technology specialist collaborated with two science teachers from Parkside High School in Salisbury, MD, to develop instructional materials.
- "Drinking Water Quality" and "The Interactions of Species and Organisms within Their Environment" were identified as the two units to be developed.
- A team approach was used to design and develop engaging hands-on instructional units that would stimulate students and help them to understand a science concept through an agricultural application.
  - The university faculty worked with the teachers to ensure that the instructional units reflected new technology, research, and innovation in agricultural sciences.
  - The curriculum specialist guided the teachers in developing their units, assuring not only that the units address multiple levels of learning outcomes such as synthesis, integration, and evaluation, but also that the units can be differentiated for multiple learning styles.
  - The teachers worked closely with the technology specialist to develop instructional materials such as video, poster (large format print), and PowerPoint presentations.
  - By the end of July 2009, each teacher had developed three to four week instructional units that included hands on experiments to be used by students.
- During 2009-2010 academic school year, the units were pilot tested.
- The units are being refined and will be burned to compact disks for dissemination to non-participating teachers in county-wide professional development activities and other outreach initiatives.

Results and Discussions

Given below are lesson overviews of the two units and comments from the teachers regarding the pilot testing of the units.

Unit: WHOSE JOB IS IT TO PROTECT OUR WATER?

Investigating Water Quality as an Introduction to Basic Chemistry for Biology Students in a Secondary Setting

Developed by David Vogel, Parkside High School, Salisbury, Maryland

Topic	Title, Description, and Objectives
Biological Contaminants Lab Part 1	**Life in a Drop of Water** • Observe organisms in pond water (demonstration) • Test well, pond, and municipal water for *E. Coli* and total coliform • View *Life in a Drop of Water* Video **Resources:** Petri film, spreaders, gloves, 2 mL graduated plastic pipettes, markers, water samples from home, bottles, Ziplock bags, ice (previous day), pond water, aquarium water, incubator, autoclave (35C)
Biological Contaminants Lab Part 2	**What is Alive in My Water?** • Count *E. Coli* and total coliform from Petri film • Discuss biological contaminant pollution sources • Examine health effects **Resources:** • Petri film from previous day • **Handout:** Analyzing Petri film • **Poster:** Wicomico County Map
Nonliving Contaminants Lab	**So That's Why My Water Tastes Like That…** • Test for nitrates, pH, lead, and hardness • Compare drinking water, well water, tap water, pure pond water • Consider health effects **Resources:** • Copper, nitrates, pH, and hardness strips; well water, student contaminated well water sample from previous lab, • **Handout:** Water Quality and Health Effects • **Chart:** Health Effects • **Poster:** Wicomico County Map
Protecting and Conserving Drinking Water	**Managing Our Water Sources** • Discuss protection and conservation of water • Describe safe drinking water • Review government/career roles in water conservation and protection **Resources:** • **Handout:** EPA Reading Guide • **Handout:** Water Usage Log Homework • **Booklet:** EPA Activity Booklet
Conservation and Water Quality	**Managing Our Water Use** • Discuss and present results of water use • Discuss individual role in water quality • Present results and final product (brochure or poster)
Guest Speaker	**Whose Job is It?** • Have guest speaker associated with water quality - Farmer, county water person, etc • Discuss science and technology behind environmental pollution • Examine till versus no till methods • Explore conservation effectiveness of GPS in farm equipment

Teacher Comments

- There was a significant increase by 26% from the previous year in overall student performance
- "I think this unit greatly helped me teach the content, and preparing the unit has increased my skills as an educator."

  Note: Mr. Vogel was asked to be a part of a select group of teachers that will write science curriculum for Wicomico County during summer 2010.

University agriculture faculty and high school science teachers discuss ways to enhance science curriculum.

Unit: Ecosystem Interactions

Developed by Mike Campbell, Parkside High School, Salisbury, Maryland

Topic	Title, Description, and Objectives
Populations, Genetic Diversity and Symbiosis	**Diversity leads to Stability:** • Use student diversity and career choices as an analogy to the importance of species' niches being fulfilled through biodiversity. • Examine how interactions between a species and its environment define a species niche. • Explain how a species adapts to its niche. • Define symbiosis and state the effects of symbiotic relationships on populations. • Relate social diversity to that of ecological diversity. • Invent analogies of human careers and niches that various species fulfill.
	Genetic Biodiversity Lab: • Use the naturally occurring albino mutation of corn plants as an example of genetic biodiversity. • Describe how the impact of humans on the environment has increased over time. • Observe and examine genetic biodiversity among corn plants. • Relate the importance of genetic biodiversity to species interaction and survival.
Symbiosis and the Cycles of Matter	**Nitrogen in the environment:** • Explore the nitrogen cycle and the organisms affecting it and affected by it. • Relate the nitrogen requirement of plants to the use of fertilizers and alternative means of adding nitrogen to the soil. • Explain carbon and nitrogen cycles. • Explain how a species adapts to its niche. • Describe the importance of nitrogen for plants and animals. • List possible means of adding nitrogen to the soil for crops.
	Legumes Symbiosis Lab: • Examine the nodules of legumes (Lima beans and Soybeans) planted on "Day 0" as a symbiotic relationship between plants and bacteria. • Explain carbon and nitrogen cycles. • Explain how a species adapts to its niche. • Define symbiosis and state the effects of symbiotic relationships on populations. • Analyze nodules of legumes for nitrogen fixation. • State the effects of symbiosis of legumes on bacterial populations.

Teacher's Comments

- Students enjoyed the activities and the hands-on aspect of the unit
- The teacher attributed the increase in test scores to the increase in hands-on activities and student-driven discovery of information that was built into this unit
- "As a teacher, I found this program extremely beneficial for creating unit materials and as a professional development tool. Working with a variety of support systems such as one-on-one time with professors and advice from Ms. Cotton, Mrs. Harned, and Mrs. Waller was extremely helpful and enjoyable."

Conclusion

- The initial results of the pilot test indicate that the experiential activities were considered very beneficial and student learning was enhanced.
- The result of the collaboration and team approach was effective, stimulating instructional units. Based on the student response during pilot testing, the units will serve to enhance curriculum at the county and state levels, and also serve to broaden student perception of the agricultural sciences.