

Undergraduate Research Coupled with Service Learning in General Education Science Courses

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Student Motivation, Engagement & Achievement

- ◆Typically relatively low for non-science majors in general education natural science courses
- ◆Students often don't understand why they are required to take these courses
- ◆Students in these courses often don't want to be there and resent the requirement
- ◆Student preparation and interest in science is often low
- ◆Student performance in these classes is often weak

Real Research

- ◆Students participate in a real scientific investigation - measuring the level of crude oil contamination in water samples from private water wells in Wood County
- ◆Collaboration with the Wood County Health Department, the Ohio EPA, and the Ohio Department of Natural Resources

Wood County Water Wells, A Serious Health Hazard?

- ◆ Once part of the largest oil field in the country but nearly all of its approximately 36,000 wells were abandoned by 1920
- ◆ These wells represent a potential source of contamination of the ground water used by rural residential water wells
- ◆ Students are challenged to determine whether a health risk exists in our county from this contamination source



Meeting Real Human Needs

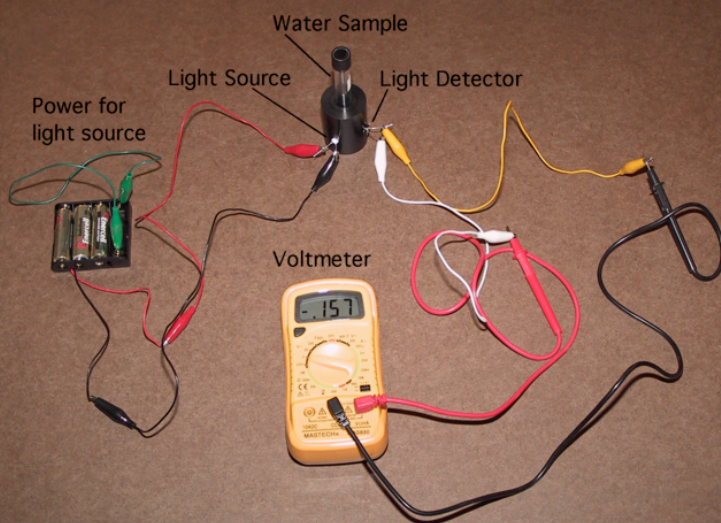
- ◆ Testing water samples of wells used by real people in Wood County
- ◆ Results can help determine who is using contaminated water
- ◆ Knowing who has used contaminated water may help to determine whether any health effects are associated with its use

Rigorous Scientific Criteria: Accuracy & Reproducibility

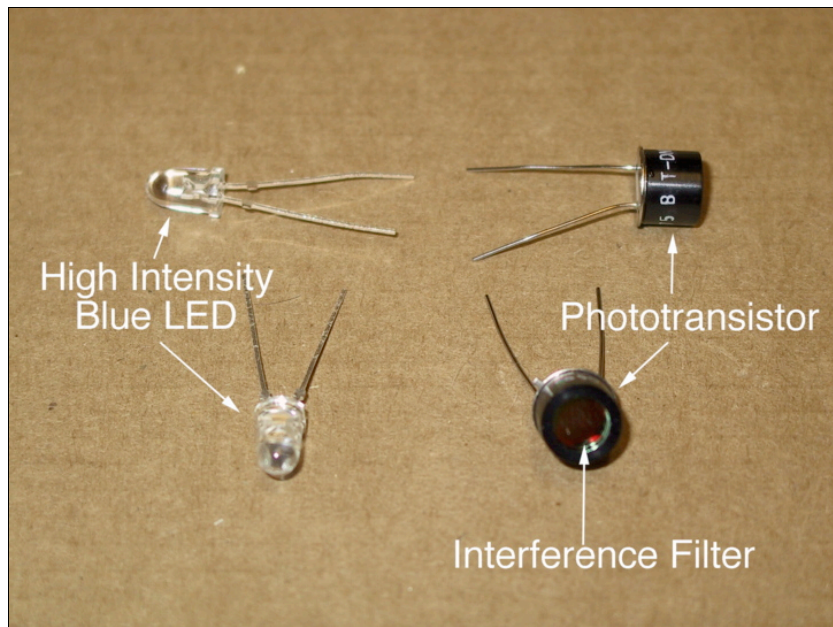
- ◆ Students must be certified as reliable and valid water testers using known and blind water contamination standards
- ◆ Each well sample is divided into a minimum of four replicates for testing by four independent student groups

Wood County Wells Investigation

- ◆ Wood County Health Department and Ohio EPA scientists and a prominent local well driller introduce the question
- ◆ Students assemble and optimize a simple field fluorimeter for testing well water samples for petroleum contamination
- ◆ Students perform solid phase extraction and screen water samples from private wells for contamination



Field Fluorimeter Built By Students







Extracting water with the SPE disc

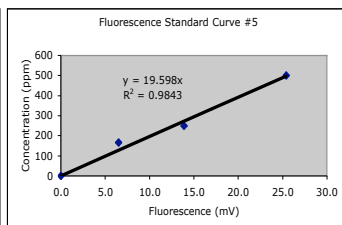
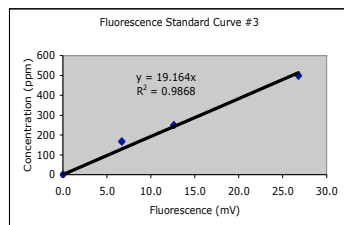
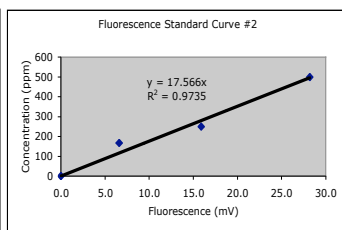
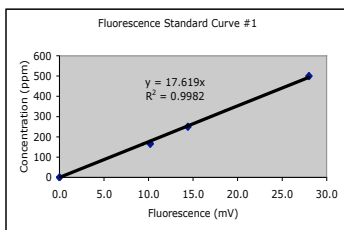


Extracting the SPE disc with toluene



Student Data: Fluorescence Standard Curves

Detection limit < 0.2 ppm total crude oil (before extraction)



Current Assessment Results

External Evaluators

- ◆ Students posters evaluated by scientists from the Wood County Health Department, Ohio EPA, Director of the BGSU Environmental Science Program, Director of the BGSU Environmental Health Program
- ◆ Reports indicate a very high level of student understanding of their work and the concepts on which it is based, as well as a high level of ability to communicate that understanding

Assessment Results:

Student Reports

- ◆ In recent semesters in which students were testing real water samples, every student reflection reported a positive attitude about the course.
- ◆ “My attitude towards science was much different at the beginning of the year because I really did not enjoy it...My scientific ability was not that strong because I did not enjoy science...My understanding about science now is much stronger than ever before...Science would play a big part in the making of my decisions...It was extremely interesting and satisfying to get results.”

More Student Quotes

(Hands-On with Service)

“The only experiences I had with science before this course were common high school classes. I found science to mean boring, mindless, uncreative work that was a waste of my time. I really wanted to stay away from science, but this course description made it sound more like something I would enjoy...Now I understand that scientific work can be very creative and very useful.”

“Now that the class is over I feel that I have learned more about science than I ever did in all my high school courses combined.”

On the first day of class...“I really did not like science at all...My scientific ability on the first day of this course was awful...My understanding of science now is much better...I feel that there is a lot more that I can learn and I would like to.”

“This new experience excited me.”

“Thinking back to the first day of science I was nervous and scared because I have never done well in science...On the first day of this course my scientific ability was not good...My understanding of science has broadened a lot. This class was like a key opening up a new, understandable world of science.”

More Student Quotes (Hands-On with Service)

"I would for sure love to take another course like this one. I think knowing that it could benefit others was what gave us the drive to actually do the most that we could in such a small amount of time. I find it appealing because its not just answering some random questions out of a test book about something I'll never have to deal with in my life again. It was one of those things where you know you will need it later in life and it actually will benefit others so if you have to take a class, why not take one for the team and for the good of other people. It was also very interesting and about something I never would have known if I hadn't taken the class."

"I really would like to do something like this again where I know that I am helping out other people outside the university. It helped me realize that this is an actual problem going on right by us and that helped me learn better. I think other courses like this would help not only me but other students as well. I find it better because of what I mentioned before, it is like reality, the problem actually occurs and by doing the work, we can solve the problem, and get a grade for it at the same time."

"I would like to take other courses like this because in high school I always thought that science was so pointless and useless, and I never knew when I would be able to use this. The Journeys class was beneficial to other people and it was useful."

"I like science when it is used to help ensure the safety of people. I enjoyed the work we did this past semester to help the residents of Wood County. I would most like to do science that helps people."

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More Student Quotes (Hands-On with Service)

"...I think it is great that I learned information that others didn't know and that that information could be used to better someone else's life. I like the fact that this experiment had a purpose that could affect the way that people live."

"I loved the science course. I liked how it was hands on and that we were helping people in the process. It wasn't like any other science class I have taken, we were actually helping the community out and learning the material in the process...I think this method of instruction was very effective. I learned a lot more in this class then I have in any other science class I have taken. I was able to learn science this way and it was very enjoyable."

"I enjoyed the more "hands on" approach. It made the class a lot more interesting than regular science classes. Thus, I feel as though I was able to learn about science more easily. Also, because I was able to help actual people, I took the class more seriously than previous science courses I have taken. Thus, I was able to retain the knowledge I learned more easily. Also, this class was not only educational, but also fun. I feel as though this method of teaching is extremely effective."

"My favorite part of the way this science course was constructed is how what I learned about water contamination I actually got to put to use. I liked how I learned how to put a circuit together, perform solid and liquid phase extraction, and how to test water for crude oil contamination. All of those things that I learned actually felt useful. In other courses I continuously learn things that will never be used. I feel like it just wastes time."

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Conclusions: Factors That May Account for Increased Motivation & Engagement

- ◆ Experiential nature (hands-on)
- ◆ Students perceive that this is a *real* investigation
- ◆ Students perceive that they are providing a benefit to local people
- ◆ Students make decisions in their work
 - ✔ (the more the better, but they must be equipped to make good decisions)
- ◆ Students work in pairs/groups but both group *and* individual accountability is important

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Real Learning AND Real Scientific Research

- ◆The results of this investigation should be publishable in peer-reviewed scientific journals
 - ✓All of the requirements of rigorous scientific research are being met
- ◆At the same time that innovative pedagogy is being implemented real research is being accomplished
- ◆And at the same time that real research is being accomplished, a contribution is being made to the welfare of the local community

Investigating Impact of CAFOs on Wood County Water Quality

- ◆New large dairies are being built and operated in Wood County
- ◆Most rural residents deeply concerned about adverse impacts
 - ✓health, environment, quality of life
 - ✓property values
 - ✓infrastructure - roads
- ◆State granted permits for every dairy despite strong public opposition

Students Monitoring Water Quality

- ◆Collect water samples using Wood County Health Department and EPA approved protocols
- ◆Observation of conditions, measurement on site of pH, dissolved oxygen, water temperature, conductivity
- ◆Assay for coliform and *E. coli*
- ◆Determine level of nitrate, ammonia, reactive phosphate
- ◆Data collected for more about 60 sites since October 2006
- ◆Collaboration with WHCD, OEPA, USGS









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Clyde, Ohio Childhood Cancer Cluster

- ◆ About 2800 children age 0-19 live in Green Township including City of Clyde
- ✓ 2000 Census data
- ◆ Prior to 2001 almost no cases of childhood cancer in Clyde, OH

1996-2000	2001	2002	2003	2004	2005	2006
1	2	1	1	0	2	7

Ohio Department of Health Report

- ◆ Issued April 17, 2007
- ◆ Found incidence of childhood cancer in Clyde City and Green Township significantly higher than expected for period 2002-2006

Cause?

- ◆ Whirlpool manufacturing plant emits thousands of pounds of volatile organics and other compounds from coatings
- ◆ Vickery Environmental injects millions of gallons of hazardous waste into deep wells
 - ✓ recently thick, black material found emitting from springs in Lake Erie
- ◆ OEPA found Racoon Creek, passing through Clyde, highly contaminated, devoid of life downstream of Clyde wastewater treatment plant
 - ✓ various chemicals and metals
 - ✓ a variety of industrial sources