Assessment of Learning Experiences of Undergraduate Researchers in an NSF/REU Site on Watershed Sciences and Engineering

Vinod K. Lohani
vlohani@vt.edu

Tamim Younos
tyounos@vt.edu

Virginia Tech

2009 AWRA Spring Specialty Conference, Anchorage, Alaska
May 04-06, 2009
Outline

• NSF- Research Experiences for Undergraduates (REU) site
  – Proposal review experiences
• Summary of research work
• Assessment of Learning Experiences
• Research work extension as PhD research
• Summary
Interdisciplinary Learning

Educating the Engineer of 2020, 2005 NAE report (www.nae.edu)

“Engineering schools introduce interdisciplinary learning in the undergraduate environment, rather than having it as an exclusive feature of the graduate program.”
NSF/REU Site: 2007-10

• **Title:** Interdisciplinary NSF/Research Experiences for Undergraduates (REU) Site on Watershed Sciences and Engineering

• Research mentors’ disciplinary background:
  Civil engineering, environmental engineering, electrical engineering, geology, biology, crop and environmental sciences, water resources, environmental chemistry, engineering education, and academic assessment.
Proposal review process

- 2004 Submission; Amount: $389k; Duration Proposed: 5 years

The panel was concerned that the various projects, thematically centered on "water," seemed only tangentially related to one another. The program would benefit from a tightened, more cohesive focus showing how the projects/students/faculty interact and interrelate intellectually. Proposal wasn’t recommended for funding.

Our response
The authors brought this to the attention of various research mentors and made sure that all proposed projects are interrelated in some logical way and are described adequately. The keywords that describe the focus of the site were also included in all project descriptions.
Proposal review process

• 2005 Submission; Amount: $488k; Duration Proposed: 5 years
  • The panel felt that for an initial proposal, a 3-year program would be more appropriate than a 5-year one. Description of the research facilities not provided. Proposal wasn’t recommended for funding.

Our response
• For the next submission, we reduced the duration of site to 3 years. Authors felt that research facilities were adequately described.
Proposal review process

• 2006 Submission; Amount: $368k; Duration Proposed: 3 years; amount approved $300k.

• Proposal was funded and NSF/REU site began in summer 2007. We have successfully completed 2 years. This year our 10-week long site work begins May 31, 2009.
Our advice for NSF/REU grant writers

• Initially it’s a good idea to go for a 3-year long REU site.
• Make sure your stipend level matches the national average.
• Discuss proposed technical activities and integrating theme clearly. In our case integrating theme was “water.” Also, don’t forget to discuss REU fellows’ social activities.
• Include well defined recruitment, dissemination and assessment plans.
• We always discussed the modification made with the NSF program official before making the submission.

Contact person at NSF: Dr. Esther Bolding (ebolding@vt.edu)
Our undergraduate researchers: 2007 & 2008 cohorts
Site implementation

• Day 1: Orientation, pre-survey, meetings with research mentors, expectations from fellows, group lunch
• Research activities under supervision of 1-2 research mentor/s
• Weekly forums: Friday afternoon 2-4PM
• Last day: Presentations (15 min) by each student, post-site survey, focus group, group lunch
Students in Action!
Social Activities
## Example Projects – 2008 Cohort

<table>
<thead>
<tr>
<th>Faculty Mentor Discipline</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Resources Research Center &amp; Geography Civil &amp; Environmental Engineering</td>
<td>Evaluation of Decentralized and Small-Scale Drinking Water Systems in Mexico The Characteristics and Chemical Performance of Polyethylene and Poly (1-butene) Pipes Removed from a Water Distribution System</td>
</tr>
<tr>
<td>Water Resources Research Center &amp; Engineering Education</td>
<td>Water Quality Assessment of a Mixed Land Use Watershed</td>
</tr>
<tr>
<td>Water Resources Research Center &amp; Engineering Education</td>
<td>Green Building Design: A Case Study Application to Car Dealership and Implications for Water and Energy Conservation</td>
</tr>
<tr>
<td>Civil &amp; Environmental Engineering</td>
<td>Impacts of Hypolimnetic Oxygenation Systems in a Drinking Water reservoir</td>
</tr>
<tr>
<td>Geology</td>
<td>Investigation of Roxarsone Biotransformation under Aerobic Conditions</td>
</tr>
<tr>
<td>Engineering Education &amp; Water Resources Research Center</td>
<td>Integration of LabVIEW into Stroubles Creek Watershed Assessment</td>
</tr>
<tr>
<td>Crop &amp; Soil Environmental Sciences</td>
<td>Persistence of Fecal Indicator Bacteria (Enterococcus) in Fairview Beach Sands and Sediments</td>
</tr>
</tbody>
</table>
Research products

- Part I: Program overview document – ~25 page document
- Part II: Research proceedings – ~100 page document that includes a paper by each research fellow
- Conference papers
- For details, pl. see: http://www.vwrcc.vt.edu/nsf_reu.html
Assessment of Learning Experiences

• Two external experts (former academic assessment director at VT and an expert from Clemson Univ.) assist in site assessment work.

• Assessment tools
  – Pre- and post surveys (expert 1)
  – Focus group at the end of 10-week session (expert 1)
  – Self-reflections
  – Post site assessment (expert 2)
Pre-and Post-survey

Scale: 1=Strongly Disagree; 2=Disagree; 3=Neutral/No Opinion; 4=Agree; 5=Strongly Agree

1. I have an appreciation for the role of faculty in advising students.
2. Studying water is interesting.
3. I have an appreciation for the role of faculty in research.
4. I am interested in going to graduate school.
5. There are many opportunities for employment in the water field.
6. I am aware of many ways in which scientists serve with their communities.
7. I am aware of the many ways in which scientists from different fields interact with each other in conducting research in watershed sciences.
8. I have a good understanding of the role of ethics in scientific investigations.
10. I can communicate scientific concepts effectively to a scientific audience.
11. I can communicate scientific concepts effectively to a non-scientific audience.
12. I know everything that I need to know to conduct scientific research in the library.
15. I am confident that I understand how to conduct scientific research.
16. The Use of statistics is not important in monitoring water quality.
Pre-and post surveys 2007 & 2008
Free response questions (last day focus group session)

• What suggestions do you have for improving the application process for this NSF/REU program?
• Do you have any concerns about the program that you are beginning now? If so, what are they?
• List the top three things that you would like to learn during this 10-week long NSF/REU program.
List the top three things that you learned (within and outside of your discipline) during this program.

- Important – Should have a presentation on how to give presentations, i.e., PowerPoint, Communications
- Bacterial source tracking and methodology
- Presenting research
- How broadly something like water uses the skills of so many academic fields
- Research in general as what I want to do
- How to go about research
- How to present
- How to write a research paper
- Learn about a new area of a field (geology)
- Learning to present chemistry to non-chemists
- Presenting more pictures than text
“My NSF-REU experience at Virginia Tech has undoubtedly been the most influential experience of my collegiate career. I made lifetime friends and colleagues and learned much more than I could have anticipated. It has been an invaluable experience and as one student said could be summed up as “practice grad school.” I am very thankful for Drs. Younos and Lohani who with positive attitudes have overcome setbacks and provided a brilliant and beautiful program students interested in science. I feel that I certainly have found my “calling.” Now, it is evident that I, too, have the “affliction of curiosity,” to use the words of Dr. Marc Edwards. Perhaps now you can see why I say with clear confidence that this program has changed my life.”
Post-site assessment

- Recruitment & Selection Recommendations
  - Modifications to application
- Program Elements Recommendations
  - Final paper requirements spread over the period
- Assessment Recommendations
  - Journal entries
PhD Research Example

• Development of a real time water quality monitoring system

• Follow up work of research documented in:

Site: VT campus and Stroubles Creek, Blacksburg, VA

Figure 1. Stroubles Creek Watershed Map
Monitoring an Impaired Stream
Real time Monitoring System

MiniSonde 4a

Serial Communication

Server

Computer + LabVIEW

Data transferred via wireless LAN transmission

Client Computer + LabVIEW

Source: Distributed Sensing Systems for Water Quality Assessment and Management? 2004-08
LabVIEW

- Graphical Programming
- Dataflow
- Acquire, analyze, present

Front Panel
Block Diagram
Real Time Monitoring System

LEWAS: Phase 1

- Temperature, D.O., Conductivity, and pH
- Sends digital output to PC

Tablet PC

Client(s) Computers + LabVIEW

Data transferred via wireless LAN

LEWAS Lab, McBryde
3rd Floor

Torgerson 2150
Field Deployment, Duck Pond is a potential site
Water Quality Parameters

• MiniSonde Monitors:
  – Temperature
  – pH
  – Dissolved Oxygen
  – Conductivity

• Capability to observe changes and relationships over time and during specific rainfall events
Data Acquisition (DAQ) System Block Diagram

Physical System → Transducer Sensor → Signal Conditioning → A/D Converter → Computer

- Physical Variable: Temperature, Pressure, Electrical Signal, Motion, Flow
- Noisy Electrical Signal
- Filtered and Amplified Signal
- 8-Bit Resolution
- 16 Samples Per Cycle
- Digitized Signal
- 8-Bit Binary Code
Part of the Block Diagram that extracts water quality data from information sent by the sonde.
Measured water quality parameters
Summary

• Completed first two years of NSF/REU site successfully
• Ten new students will begin site work May 31, 2009
• Enhancement of engineering curriculum by incorporating hands-on learning
• We’ll submit our project for renewal in June 2009
The success of our NSF REU program is attributed to very constructive contributions from research mentors (Drs. Dietrich, Edwards, Burbey, Hagedorn, Schreiber, Little, Webster, Kachroo, Vallet), members of program management team (Drs. Sanders, Muffo and Trenor). Also thanks are due to several graduate students and laboratory personnel, and those who provided support for social activities. The program success to a great extent is the result of NSF/REU fellows’ enthusiastic participation and work ethics. **The NSF/REU program is supported through the NSF grant No. 0649070. We sincerely acknowledge NSF’s support.**