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From Science Labs to Browser Tabs: A Fully Actualized Remote Science Teaching Lab

Paul (PJ) Bennett, PhD

Colorado Community College System, 1520 Miller St., Arvada CO 80002 USA
(Paul.Bennett@cccs.edu)

The North American Network of Science Labs Online (NANSLO) is an open source (Creative Commons BY license) project that seeks to develop a network of remote web-based science labs (RWSL) that offers access to Internet mediated real-time operation of high-end scientific instrumentation to conduct laboratory activities. The primary student population for NANSLO is students that normally do not have access to traditional STEM courses because of location, family, and/or work commitments. This article and accompanying poster provides a brief introduction to the goals, methods, and accomplishments of the first several years of NANSLO operation.

Keywords: Remote Science Lab

Link to Original Poster:
http://www.ableweb.org/volumes/vol-36/poster?art=54

Introduction

Many people do not believe it is even possible to teach laboratory science online. We find this a truly remarkable idea since we have been conducting scientific research remotely for many years (Fig.1). Additionally, the tremendous growth of online education over the last decade from 1.6 to 6.7 million students (Allen and Seaman, 2013) indicates that we have an obligation to find a way to teach laboratory science online. One of the approaches that the Colorado Community College System (CCCS) is taking is the implementation of The North American Network of Science Labs Online (NANSLO).

NANSLO is a network of Remote Web-based Science Labs (RWSLs) used to conduct real-time inquiry-based laboratory procedures on high-end scientific equipment. NANSLO was created in 2011 with a Next Generation Learning Challenges grant. The goal of this grant was to replicate the RWSL at North Island College in British Columbia, Canada. NANSLO is operating under a Department of Labor Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant until October 2016. We have used the TAACCCT grant for two main things: building a third NANSLO node at Montana State University - Great Falls College in Great Falls, Montana and expanding the laboratory activities that we have available to offer.

Since the creation of the NANSLO project, the RWSL (also called a NANSLO Node) at the Colorado Community College System (CCCS) in Denver (hereafter called the Denver Node) has served lab activities to first year STEM students in biology, chemistry, and physics laboratory courses. To date the Denver Node has served more than 1700 students. The students have been located in 32 states and several locations around the world (Table 1). The Denver Node has also provided laboratory activities to several other colleges as part of the TAACCCT grant.

CCCS's interest in a NANSLO Node had to do with pre-existing online lab science courses. Traditionally, laboratory courses taught online through CCCS schools have used lab kits exclusively. A lab kit is a collection of materials and instrumentation that is sent to the students allowing them to do their lab activities at home. One of the persistently listed problems with lab kits is that there is "No immediate instructor assistance or peer communications"(Jeschofnig and Jeschofnig, 2011). As part of its design NANSLO includes a real-time voice conference tool which the students find very helpful when speaking with their fellow students (Table 2).

We have not been as successful in dealing with providing the students a way to communicate with their instructors (Table 2). Often instructors do not log on to the lab times because their students are not all scheduled at the same time. It is unlikely with our current operational scheme that stu-

dents will ever find it as convenient to schedule a NANSLO lab as a kit lab (Table 2) since they can quite literally do their lab kits at any time. However the fact that 68% of the students agreed or strongly agreed that it was convenient to schedule a NANSLO lab suggests our available times and scheduling process are reasonable for most of our students.

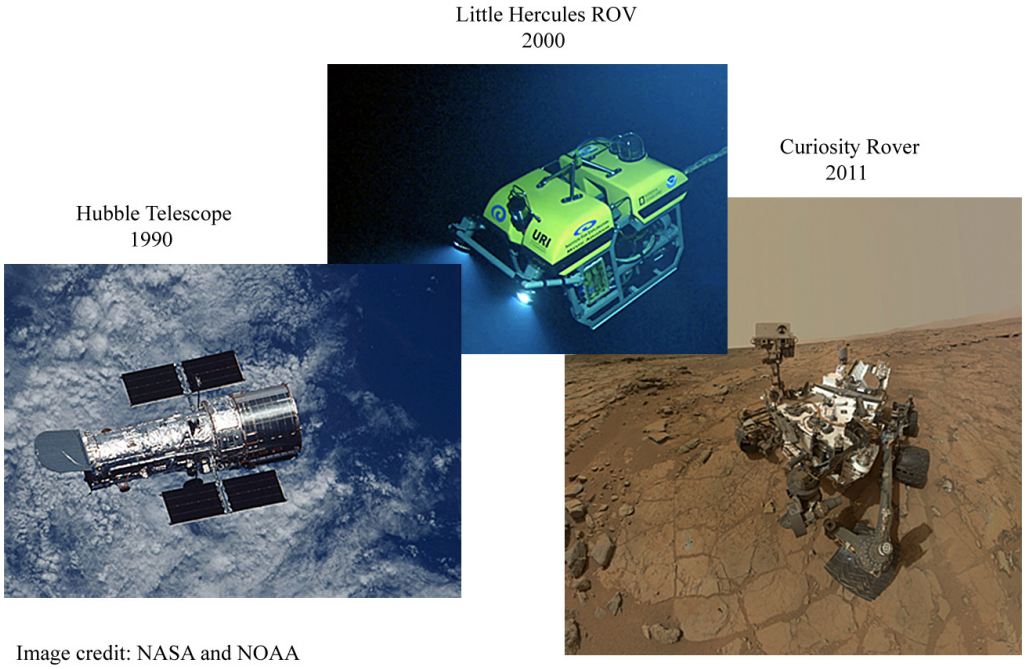

Figure 1. Remote science experiments

Table 1. CCCOnline student locations for 2014 calendar year.*

State or APO	Number of Students	State or APO	Number of Students	State or APO	Number of Students	State or APO	Number of Students
Alabama		Kansas	1	New Mexico	1	Virginia	3
Alaska		Kentucky	2	New York	4	Washington	5
Arizona		Louisiana	2	North Carolina	2	West Virginia	
Arkansas		Maine		North Dakota		Wisconsin	
California	18	Maryland	2	Ohio	2	Wyoming	5
Colorado	876	Massachusetts		Oklahoma	1		
Connecticut	6	Michigan	2	Oregon	2		
Delaware		Minnesota		Pennsylvania			
Florida	5	Mississippi		Rhode Island			
Georgia	2	Missouri	1	South Carolina	2		
Hawaii	3	Montana	8	South Dakota	1	Armed Forces Africa, Canada, Europe, Middle East	3
Idaho	2	Nebraska	2	Tennessee	3	Armed Forces Pacific	1
Illinois	4	Nevada	3	Texas	8	Delhi	1
Indiana		New Hampshire		Utah	6	Korea	1
Iowa	1	New Jersey		Vermont		Taiwan	1

*Data Provided Colorado Community College Online student demographics reports.

In addition to the data that we collected under the NGLC grant we have also been collecting data from the TAACCT grant. We will be using this data to inform some of the future directions that we will pursue in the continued growth of the NANSLO project. We have feedback from both the NGLC grant and our current projects that shows we need to work on a greater integration of the faculty. For instance, although well-detailed instructions are often provided to instructors and are included in the procedures, we received comments from students during our current research such as (quotes from Denver Node lab activity survey):

"I had no idea there were NANSLO videos to watch, so I first started the lab I felt extremely stressed"

"The access instructions for the lab through *[school name removed]* community college were very poor."

Table 2. Percent of students who agree or strongly agree with the question.*

	Percent Agree/Strongly Agree	
	NANSLO Remote labs	**Lab Kit labs**
Was convenient to schedule.	68%	87%
Gave me the opportunity to work with other students.	53%	16%
Gave me the opportunity to ask of the instructors questions	20%	26%

- *Data provided Inverness Research Inc. NGLC grant report.

However, we are quite confident that this approach to conducting online science labs could prove very successful as the following comments from students (quotes from Denver Node lab activity survey):

"Superior! Fun and informative experiment. Lab support was exceptional and professional. Would be interested in participating in future experiments."

"Thank you very much for allowing us to participate in this experiment!! It was very fun and interesting, and a bit of a challenge! (In a good way!)"

Acknowledgements

I would like to acknowledge our many collaborators without which the NANSLO project would not have been possible. These collaborators include the other two NANSLO nodes: North Island College, Canada and especially Albert Balbon, founder of the first RWSL; and Great Falls College Montana State University, Montana, and NANSLO lab director Brenda Canine. Other collaborators I wish to thank include: Flathead Valley Community College, Montana; Kodiak College/University of Alaska, Alaska; Lake Area Technical College, South Dakota; Laramie County Community College, Wyoming; Otero Junior College, Colorado; Pueblo Community College, Colorado; and Red Rocks Community College, Colorado. I also wish to thank the Western Interstate Commission on Higher Education for their input and discussions on developing this project.

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About the Authors

Dr. Bennett is currently the lab technology manager for the Colorado North American Network of Science Labs Online (NANSLO). His main job responsibilities are to develop new laboratory activities, maintain laboratory equipment, including both scientific and information technology, and supervise laboratory personnel. Previously he has been an academic technology consultant (2012), an assistant director of the graduate teacher program (2011-06), and lead graduate teacher for the graduate teacher program (2001-03) at the University Colorado - Boulder. He was also a laboratory technician for the National Institute of Child Health and Human Development (1997-99) at the National Institutes of Health. Currently he is focused on understanding the impact and uses of technology in science education. He also has a strong interest in improving science education with particular focus on the nature of science and teaching in the laboratory. In his free time, Dr. Bennett enjoys nature photography and cooking.

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