

Neil Bramsen

Sussex Inlet Public School, NSW

Macquarie Capital Science Scholarship

2009

*Innovative and Engaging use of Technology in K-12 Science and Environmental
Education*

neil.bramsen@det.nsw.edu.au

Introduction

The focus of my study tour was to explore the innovative and engaging use of information and communication technology (ICT) in science and environmental education. I identified the North American Association of Environmental Education (NAAEE) National Conference as the springboard for visits to schools, universities, institutions and education centres over a four week period in October 2009.

The study tour resulted in a wonderful immersion into environmental and science education and its interpretations through the eyes and philosophies of the various educational bodies that I visited. Many educators with an interest in ICT use that I spoke with were curious as to how my combined interests of 'technology' and 'environmental education' were being received by other educators in the field as the two are sometimes perceived as diametrically opposed. Once I made it clear that my interest was in constructivist learning and how the valid use of ICT might enhance or better enable student centred learning to take place through activities such as data collection and interpretation, or through communication and interaction with appropriate Web 2.0 applications, I found that fellow educators were not only accepting and supportive but also knowledgeable, generous and committed to quality teaching and learning.

'Rather than viewing technology as an enemy of environmental literacy, we are convinced that technology based learning can help cultivate an environmental sensibility by serving as a 'bridge' to the outdoors.' (Streamwebs: The Freshwater Trust Information Sheet, handout NAAEE conference 2009)

The Visits – A Summary

Island Wood (The School in the Woods) – Bainbridge Island, Seattle, Washington

[Island Wood](#) is a residential environmental education centre with a commitment to sustainability demonstrated through efficient waste management strategies, a school garden and solar power. From a technology in environmental education perspective my host Clancy Wolf utilises ICT when it enhances real opportunity for learning. Examples include the microscope lab, weather stations, data logging and GPS activities. The use of iPods was a highlight; when an educator is in the field with a group of students and a bird is sighted, a *learning moment* occurs and the iPod is produced and used to identify the species (album cover), provide detailed text (lyrics) and with the aid of a small speaker play the birds call (MP3). In this instance the iPod is functioning as a field guide but with the added advantage of playing the actual bird call. The content itself could be generated by students through visual art or through sourcing images, MP3s and data as part of a web research project.

North American Association of Environmental Education Conference - Portland, Oregon

Four days were spent attending a range of sessions. With over 1400 delegates and up to twenty concurrent sessions it was an exciting and busy time. Sessions that I participated in included;

- Building Community Stewardship Through Schoolyard Ecological Restoration
-1 day field trip
- Interactive Maps: GIS that Doesn't Cost the Google Earth
- Climate Change, Changing World; Tackling the Global Warming Challenge using Online Data,
- Streamwebs: Using Technology to Cultivate a Community of Student Stewards
- Classroom at Crater Lake: Earth Caching
- Using Technology as the Bread Crumbs to Getting Kids Outdoors
- From Oregon to Sakhalin, Russia: The Salmon Watch Program

- EE Curriculum as a Foundation in Technology Training
- Urban Bird Sounds Project
- Paradise Lost: Blending Art and Science to Teach about Climate Change
- Integrating Environmental Education into the Curriculum
- Nature Journaling Across the Curriculum

Evenings were spent with fellow attendees at dinners, an open night at the Oregon Museum of Science, and informal social gatherings. I met teachers and educators from all over the USA, Ethiopia, Spain, Canada, and New Zealand along with a few other Australians. I would recommend this conference and membership of the [NAAEE](#) to anyone involved in environmental education and looking to network, build relationships and explore related programs and policy.

Key points that I took away from the conference were;

- We have increasing access to global real time data for snapshots and student learning across all learning areas but especially science and climate change.
- Increased potential for organisations/programs to go global - citizen science across the web using Web 2.0 applications, examples include Steamwebs, eBird, Journey North and Mystery Classroom
- Using the power of partnerships to leverage strengths and build learning opportunities. For a school this may mean engaging with the community, businesses, councils and agencies that bring expertise and passion in developing and supporting school programs. This in turn works to strengthen community pride and stewardship of the local school and habitat areas.
- There are significant opportunities and interest in developing inquiry based science projects that thematically integrate multiple learning areas and that leverage the Internet for research and project documentation (wikis, blogs), online applications to log and share data and images to create multimedia presentations(wikis, Google Earth and Google Maps as an example).
- GPS devices are being used widely in areas such as earthcaching and geocaching and have an increasing profile in many educational settings including formal activities in schools, education centres and national parks.
- A repeated theme from innovative educators is that successful technology adoption requires technology/equipment requiring minimal teacher/student learning to get results.

Headlands Institute, San Francisco, California

My next stop was to meet Bec Dietrich at the [Naturebridge Headlands Institute](#) on the Marin Headlands. Headlands Institute runs day and residential programs and even has a regular school kindergarten class attending an overnight trip each year. Field studies are strong and students were participating in inquiry based studies using the microscope lab to sample freshly collected algae and identify micro-organisms against a specimen sheet. Students that I spoke with were engaged and curious and detailed their findings in a comprehensive personal field journal. Interesting finds were broadcast via a scope and data projector and the entire group were able to share information and discuss the image.

KQED- Quest Science Explorations, San Francisco, California

Housed in downtown San Francisco KQED is a public broadcaster for the Bay area. As well as providing television and radio content KQED has a strong [science education](#) focus incorporating content from TV and radio into learning initiatives as well as working with schools on the ‘[Explorations](#)’ developed using Google Maps. Jessica Neely the Project Supervisor demonstrated how teachers and students can collaborate on creating community/local multimedia using Google

Maps. These maps can contain photos, video, text or scanned images of student art work that combine to create a multimedia presentation on the topic of choice. Flip video cameras were also being used to make videos; the flip has a built in USB and a simple transfer process. I view 'Explorations' as a wonderfully flexible, creative and interactive tool for developing individual or class projects and intend using them in my 2010 teaching program.

California Academy of Science, San Francisco, California

The Academy is housed in a spectacular new building that opened a year ago in Golden Gate Park. The roof is a 'living garden' representative of the local flora and is surrounded by solar panels supplying much of the building's required power. I met with Education Manager Helena Carmena who guided me through the microscope lab and outlined the way in which it offers [teachers and students](#) opportunities to undertake a range of investigations; an example being geology and the linking of mineral samples with consumable products made of the same mineral.

We also explored the classroom kits that allow teachers to borrow a suitcase containing teaching and learning resources from the Academy's collection for use in their school. This is an effective outreach program similar to the Australian Museum's [Museum in a Box](#) initiative which is supported via the NSW DET Connected Classrooms project.

The Academy has introduced GPS units to undertake surveys and treasure hunts in the nearby park with a long term view toward data collection and analysis.

Naturebridge - Yosemite Institute, Yosemite, California

Adam Burns, Field Scientist with the [Institute](#) has been incorporating GPS and Google Earth activities with recent school groups. This interesting initiative is being used to track wildlife on the valley floor via a standard GPS unit. Customised data is then exported into the open source program [GPS Babel](#) via a MS Excel or similar spreadsheet. GPS Babel interfaces the data with Google Earth by converting the .csv file into .kml. The file is dragged into Google Earth and the coordinates are placed into the correct positions on the satellite image. By then sharing this data, students can log into Google Earth at home or in the classroom and complete post-field trip activities. During my visit I spent a rewarding morning in the field with a school participating in traditional environmental education initiatives.

Monterey Bay Aquarium, Monterey, California

After meeting with Education staff including Kimberley Swan, Mary Staley and Stacia Fletcher I travelled north to Pajaro Valley High near Watsonville to experience the middle school WATCH program in action. WATCH (Watsonville Teens Conserving Habitats) is a great example of an effective partnership and outreach program between the [Aquarium](#) and a local school. Educators have teamed with science teachers from the school to deliver an inquiry based environmental science project for students in the middle years. The program features the embedded use of technology through the use of wikis, blogs and Nokia Xpress 5800 phones. Students use a secure wiki to take notes, formulate hypotheses and log data. Once a research question has been approved student teams are assigned field scientists from the Aquarium and conduct practical field studies. In the field the Nokia phones are used as a multifunction data gathering tool able to record still and moving images, audio, web browsing for spontaneous field related research and GPS logging of position. Back in the classroom images can be uploaded to a pc, geotagged in Picassa and then exported to Google Earth for viewing.

This is certainly an innovative program and the students interviewed appreciated the ability to capture images, web browse and geotag all with the one device. The project demonstrated along

with the Yosemite GPS and Lehigh University efforts what may be possible in terms of creating education programs that utilise technology to support students in undertaking investigations that develop environmental literacy.

I then visited the Discovery Labs and observed the education team as they worked with elementary and middle school students in a hands-on investigation. The use of traditional methods includes the close up observation of specimens using Kenavision microscope cameras connected to flat screen monitors. This is more effective than stand alone microscopes for this program and allows educators to communicate/demonstrate to all students as a group.

Later I met with Adam Yoshida and we had a broad ranging chat about Web 2.0 applications such as Twitter, Facebook and Wikis as means of facilitating communication and managing information. We also discussed an earlier program that used iPods as a form of interactive tour platform. Adam noted that these types of devices need a simple intuitive interface so that the user's efforts are not lost in making the technology work but in receiving content – a recurring theme with virtually every educator I spoke with.

Reference was also made to the Aquarium moving to a wiki as the main form of data and information management and delivery. This resulted in a move away from the standard folders, sub folders structure typical to Windows.

Lastly I'd like to thank Katy Scott, Education Technologist for outlining how she has built the WATCH wiki and blogs using Drupal and for demonstrating the Nokia/Picassa/GoogleEarth sequence of data management.

Lehigh University and Broughal Middle School, Bethlehem, Pennsylvania

After flying east I drove to Bethlehem, Pennsylvania to meet Alec Bodzin at Lehigh University. Alec, doctoral student Tammie Pfeffer and the team are developing web based environmental literacy units and the university has partnered with nearby Broughal Middle School to trial the modules. Al and his team have developed [previous projects](#) that have utilised GIS software such as ArcView to build online content with an environmental engineering focus. Examples include watersheds studies using GPS to make connections to the local environment. The team have now moved to the educationally targeted [MyWorld GIS](#) software that offers greater ease of use for students and teachers. It is also a more affordable solution for educational institutions when combined with Google Earth.

A current focus is the [Environmental Literacy and Inquiry](#) project that centres on land use, energy and climate change. With Year 8 teacher Lori Cirruci running the class sessions, students are using Internet based modules consisting of teacher support material, student activities and custom screen images purpose built by Lehigh University using MyWorld, Google Earth and the open source Google Earth .kml file format. The key to this initiative is the provision of a structured web based learning platform that supports teachers in implementing inquiry based science learning. Students are assisted through the provision of interactive data files and other web resources. Ideally the pedagogical framework being used will be adaptable for schools in other geographical areas that will be able to customise their own local data sets.

Frost Valley YMCA, Claryville, New York State

A few hours north of Bethlehem lie the Catskill Mountains and hidden among the hills and woods is [Frost Valley YMCA](#).

Reid Bauer hosted my visit and we talked about the program structure, clientele, environmental programming and the use of technology. The centre is an experiential environmental centre similar to Island Wood or Yosemite Institute with a strong focus on active outdoor participation and a desire to immerse its students into nature. Reid has developed a dedicated GPS program using Garmin units with positive results and a few words of wisdom. Students are taught the elements of GPS navigation and device use before completing a geocache hunt. This activity incorporates maths, science and physical activity in a structured environment where success lies in navigating to the correct point. A future extension that we discussed would be to use field based science inquiry activities through having school students contribute to the forestry program through annual logging of the GPS coordinates of trees targeted for preservation and the collection of growth data.

Reid made the point that for GPS activities to be successful in the camp environment instructors need to not only have a basic level of GPS knowledge but have confidence in the equipment's ability to function reliably and accurately. Again the feedback is consistent with other educators when outlining the pitfalls of technology integration into general programs. Specifically those teachers that follow the early adopters (who will generally accept technical challenges and resultantly plan for some failure) want the equipment to be easily operated, reliable in operation and suitable for students to operate with minimal instruction. Typical issues include battery charging, access to simple user manuals and summary sheets along with the need for adequate staff training and concise lesson plans.

State University New York –Cortland, New York State

I met with Dr Beth Shiner Klein to discuss her [Environmental Thematic Methods Block](#) subject for undergraduate students. The subject incorporates both environmental themes and technology. We visited the [Lime Hollow Centre for Environmental Education](#) and met with Peter Harrity. We talked about students undertaking learning activities and ways in which students can connect to nature in the field. Beth has been having her teaching students build podcasts that are used to connect school students to the activities that they will undertake during field studies at Lime Hollow and similar centres. Later I met with John Pinto who has recently been using web based data such as that found at [PowerNaturally](#) to explore concepts of solar power and generation with his students. Live [data](#) is available from a number of schools that have solar panels fitted. Web 2.0 applications have allowed for international collaboration between schools with links developed between the USA and Australia. A comprehensive set of lesson plans are also available to support the solar power initiative.

Cornell Lab of Ornithology, Ithaca, New York State

A highlight to finish the trip was a visit to the fascinating [Cornell Lab of Ornithology](#) in Ithaca. Meeting with education staff including Colleen McLinn, Jennifer Fee, Tina Phillips and Karen Purcell we discussed the powers of citizen science to enthuse and engage schools and the community in real science. A keystone program is [Birdsleuth](#) which now has over one thousand schools participating and is an inquiry based modular program with extensive teacher and well developed Internet support. This was one of the more advanced curriculum integrated programs that I experienced and has considerable educational merit. [eBird](#), Project Nestwatch, Project Feederwatch and Nestcam also are available to schools and are well structured with considerable educational merit.

Conclusions

Student centred learning using the power of three– GPS Units – Google Earth/Maps – Web Based Frameworks

During my trip I experienced a vast range of traditional and new field technologies from magnifiers and microscopes, weather stations and digital cameras (never to be underestimated in the hands of a student) to more recently embraced devices such as data loggers, GPS units, iPods and Nokia smartphones. The Internet offers seemingly limitless learning opportunities demonstrated by the likes of Google Earth and Google Maps and the range of Web 2.0 applications whereby students and teachers are empowered to control function and generate content to create more meaningful learning. [Scribblemaps](#) is a web based application allowing easy editing and drawing on Google Maps and a number of valuable mapping tools can be found at <http://freegeographytools.com/>.

“We can also engage students with digital media tools, such as photo-sharing, video-publishing and mapmaking programs, to give them opportunities to demonstrate their mastery of a concept and simultaneously reinforce their literacy skills by having them create their own content.” KQED

I am excited by the emerging use of GPS units for both traditional geocache/treasure hunt activities and as devices for capturing data used in inquiry investigations such as the projects happening at Lehigh University, Pajaro Valley High, Yosemite and Frost Valley. I believe GPS units offer significant real learning opportunities for students when combined with long term monitoring of species or habitat in school and local environments. When further combined with mapping software such as Google Earth the opportunities are even greater to model findings and engage learners through advanced visual representation of data. A web site that has a number of GPS activities and links can be found at <http://sciencespot.net/Pages/classgpslsn.html>.

The technologies I witnessed in action such as cameras, smart phones and GPS units enable data collection and analysis in the field and thus offer real learning moments contributing to constructivist learning. When that data is collated, discussed and shared using Web 2.0 applications such as blogs, wikis and custom platforms then collaborative learning and understanding on a global scale can be a reality. Today we can forge links between a school in country NSW and schools in rural America or Europe with a view to building greater understanding and appreciations of not only cultures, but for example science focused investigations looking at weather, climate and natural resource management practices.

Yet while this active student participation and construction is desirable, challenges are thrown up to education authorities as to how best manage these new platforms. Education department philosophies and policies toward web filtering, user account management and password control will impact strongly on how realistically educators can adopt and implement teaching programs and inquiry based learning that emphasise the use of Web2.0 applications in the traditional classroom. An Australian article outlining these challenges can be found at <http://www.educationau.edu.au/national-software-infrastructure> and offers one perspective on this increasingly important issue.

Suggestions

Based on my studies I have outlined below some student centred inquiry based projects and ideas drawing mainly on my preferred aspects of Web 2.0, Google Earth/Maps and GPS units that may be suitable for K-12 classes.

- Birding studies – build a database/wiki of observed local birds and place online via a wiki, Google Earth/Maps. Build a fieldguide on an iPod. Conduct regular surveys using GPS to record nesting points and engage in a long term commitment to monitoring habitat. Partner with local councils, NPWS, land management agencies and community to engage and reflect community stewardship. Utilise <http://birdsinyard.net> and ideas such as those found at [Urban Birds Sounds](#).
- Flora studies – as per bird habitats but gather data of keystone flora in the school/local environment. Monitor growth patterns, use digital cameras to record on a monthly basis. Engage in long term commitment to monitoring habitat. [Project Budburst](#) is a new web based project in the USA.
- Local studies – using Google Maps and Google Earth to record trail walks, school habitats, journaling activities, build explorations as evidenced at KQED and the Explorations model. [GeGraph](#) can be used to plot custom graphs onto Google Earth.
- Engage with local agencies such as councils to identify issues/challenges in the local area. Seek to partner with councils and complete science based projects that contribute to managing the issue. E.g. survey with council staff for endangered species, study habitat, explore stormwater runoff, plot drain locations using GPS and monitor. I regularly use our [Shoalhaven City Council GIS](#) application for local studies.
- Foster a sense of scientific inquiry through regular nature journaling as part of weekly literacy activities via language, sketches and photography. Use digital microscopes to engage intimately with the micro world. Reflect and comment on seasonal change through class blogs or wikis.
- Use wikis as team based collaborative tools for constructing project knowledge and presenting findings, share this information with the school community to increase value and model use to other teachers and classes.
- Utilise video conferencing projects such as [Connected Classrooms](#) to participate in virtual excursions when distance or cost prohibits real excursions.
- From an Australian context [Murder Under the Microscope](#) demonstrates that high quality, engaging web based environmental science is happening within our schools.
- Continue to utilise established technologies such as microscopes, magnifying glasses, paper and pencil and digital cameras to capture moments, data and thoughts.
- Utilise the innovative programs and ICT support offered to schools by the [Macquarie ICT Innovations Centre](#) in Sydney.

Within the NSW education system I believe we can better utilise the NSW Department of Education Environmental Education Policy with learning activities flowing from the three focus areas of Curriculum, Resource Management and Grounds Management. NSW schools are fortunate in having policy such as this. I would suggest that there is potential for greater awareness by school leadership teams in the value of having a well developed [School Environmental Management Plan](#) that supports environmental and sustainability teaching and learning within the school.

References

Birdsleuth, Cornell Lab of Ornithology
<http://www.birds.cornell.edu/birdsleuth>

Christie, A. 2007. *Using GPS and Geocaching Engages, Empowers & Enlightens Middle School Teachers and Students*
<http://www.ncsu.edu/meridian/win2007/gps/index.htm>

Earth Partnership for Schools
http://uwarboretum.org/eps/tools_for_teachers.php

Education.au, 2009. *Web 2.0 Site Blocking in Schools*
<http://www.educationau.edu.au/national-software-infrastructure>

Free Geography Tools
<http://freegeographytools.com/>

Gegraph
<http://www.sgrillo.net/googleearth/gegraph.htm>

GPS Visualizer
<http://www.gpsvisualizer.com/>

Journey North -Web Based Learning
<http://www.learner.org/jnorth/>

KQED Science Education
http://www.kqed.org/quest/downloads/QUEST_Why_Media_08-09.pdf

KQED 'Explorations'
http://www.kqed.org/quest/downloads/QUEST_EdTrekActivity.pdf

Murder Under the Microscope
<http://www.microscope.edu.au/Public/Default.aspx>

NSW Department of Education Environmental Education Policy
http://www.curriculumsupport.education.nsw.gov.au/env_ed/index.htm
http://www.curriculumsupport.education.nsw.gov.au/env_ed/assets/pdf/eepolicy.pdf

NSW Department of Education Connected Classrooms Program
https://www.det.nsw.edu.au/strat_direction/schools/ccp/aboutccp/index.htm

NSW Department of Education Video Conferencing Events
<http://dart.det.nsw.edu.au/html/events.html>

Urban Bird Sounds Project
<http://www.urbanbirdsounds.org/>

Project Budburst
http://www.windows.ucar.edu/citizen_science/budburst/

ScribbleMaps

<http://scribblemaps.com/>

Shoalhaven City Council GIS

<http://gis.shoalhaven.nsw.gov.au/maps/>

Streamwebs: The Freshwater Trust Information Sheet, handout NAAEE conference 2009)

Wolf, C. 2003. Technology in Environmental Education

<http://www.newhorizons.org/strategies/environmental/wolf.htm>