Experiential Science Transforms Teens

An integrated science program engages high school students in field studies that become transformative experiences in their lives

Photographs: Bob Sharp

By **Bob Sharp**

WHY HAS THE LAKE level dropped more than a meter? Why are caribou being killed so frequently by highway traffic? Are we cutting the local forest in a sustainable fashion? Why has our lake become covered with algae? Is the intertidal zone impacted by our actions? Behind each of these questions lie passion and care. For more than twenty years, these have been the kinds of questions scientists and communities have asked the Experiential Science 11 (ES11) class, based in the Yukon, to study. Their interest was to have the students collect information and forward their findings so that they could make informed decisions.

In this article, I describe how such questions have sparked passion and engagement amongst students. When they have opportunities to work on "real" problems, relationships with community and scientists grow. This experiential approach to addressing community concerns leaves lasting impressions on both students and teachers. The following examples may provide others with insights into the principles, organizational arrangements and teaching practices that have been so successful in this integrated semester-long program.

During a presentation to the ES11 class years ago, a local caribou biologist described his efforts to increase the Southern Lake Herd population. After telling us that more than a dozen caribou were killed by traffic each winter, he identified the locations where they had been killed over a five year period. He then posed the following question, "Why are caribou being killed so frequently?"

When we subsequently drove that same section of the Alaska Highway as a class, we noticed that almost all caribou were killed where gravel had been spread on the highway. The next day, the discussion amongst students raised a variety of questions and speculations. Were the caribou killed while crossing the road? Why didn't the sound of trucks scare them away? Were they spending time on the road?

In response, students were asked what kind of information they would need in order to answer each question and how they would collect this information. "If we followed tracks back from the highway, we could figure out if they came directly onto the highway or if they walked parallel to it before coming onto the road". Students "backtracked"

The water level in Cowley Lake had dropped more than a meter over a two year period.

to track a number of caribou using GPS in order to find out about caribou movements near the highway. What they discovered was that caribou walked parallel to the highway for more than a kilometer (i.e. .6 miles) before moving on to the highway. Once on the highway, the caribou "cratered" on the snowplowed ridges. To find out why the caribou were attracted to the highway, students took snow samples from the ridge. The class then analyzed those samples and found high levels of salt content using conductivity, evaporation and double replacement reactions. Further research revealed that these levels were an order of magnitude greater than levels found in natural salt licks.

In subsequent semesters, students took their findings to the Department of Highways. They asked Department officials to cover newly-crushed gravel so that salt would not be needed to spread gravel evenly on highway surfaces. While students feared that officials wouldn't listen, nor change the way they have been doing things, caribou biologists countered that they found the information valuable and planned to use it as part of their argument for change. Here is how one student described the overall experience:

> *"Collecting salt from the side of the Alaska Highway and taking it into the chemistry lab at Yukon College and actually figuring out how much salt was present in the gravel to link to caribou occurrences there, integrating chemistry, biology, and ecology. This experience as holistic learning changed how I viewed education and the world around me. I also learned that education could be fun and if I found something I enjoyed learning about, like how humans encounter their environment, it was up to me to figure it out for myself."* (2003)

We were able to undertake this kind of study because Experiential Science students spend all day, every day on a full semester program which integrates biology, chemistry, geography, art, applied skills and physical education taught by a single teacher. In formulating the ES 11 program we selected courses that fit well together. All of the above courses share similar or parallel content, and could contribute to the study of community concerns. When organizing this integrated science program, we reviewed the content of related grade 11 and 12 courses, the instructional strategies used in each, and their application to place-based activities. The courses we selected in the end were ones that involved measurement, environmental observations, and the analysis of human interactions.

Three science courses fit these criteria. The grade 11 Chemistry course provided an introduction to moles, molarity and quantitative chemistry, and gave us many opportunities to measure and determine chemical concentrations within environments. The grade 11 Biology course surveys living things, examines populations and ecology. This course encourages the study of oceans, aquatic and terrestrial environments in the world around us. The grade 12 Geography course examines atmospheric dynamics, geomorphology and human interactions with environments. This course fit well into examining many features of the world around us. The "caribou on the road studies" provided the initial thread that drew all these courses together.

In 2005, members of the community living near Cowley Lake asked ES11 students to explore the problem of declining water levels in the lake. The water level had dropped more than a meter over a two year period. The class discussed the problem and suggested some possible exploratory studies to find some answers. The whole class divided into groups in order to analyze specific aspects of the lake. They monitored the lake water balance, conducted a bathometric survey, assessed water quality, recorded wildlife utilization of the lake and developed an historical account of the lake through interviews with older residents. One student recommended that we take a sample from the lake bottom to see if it had dried up in the past. Our first attempts to pull the sampling pipe out of the sediment nearly sunk the canoes that we had tied together. After that, we took samples of the lake bottom during the winter when the ice was more than 30 cm thick. Our study of these core samples led us to studies of paleolimnology, diatom populations and an analysis of paleoenvironmental conditions of the lake.

Additional studies developed through class discussions. They included the recording of snowfall and stream flows in the upper portions of the lake's drainage basin, as well as recording the use of the lake in the spring by waterfowl. Also noted were the local community's concerns about the lake. At the time, the ES11 class received a grant to purchase high quality meters for water monitoring. These have been used to increase the precision and accuracy of our surveys.

Like many other studies, those associated with Cowley Lake have taken unanticipated paths. The value of the paleolimnology to archeological finds in the area provided

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insights to the region's deglaciation about ten thousand years ago. The identification of historical periods when no diatoms were deposited in the lake's benthic environment suggested that there were periods when the lake was part of a glacial outflow river.

Studies also examined the impacts that the Whitepass and Yukon Railway has had on Cowley Lake. They created a website about Cowley Lake as a means for collecting ongoing data and keeping the community informed.

The above two examples are drawn from approximately two hundred projects undertaken by ES11 classes over the last two decades, all of which are listed on a website describing the field studies. They shed light on how a place-based activity supports and enriches integrated studies. When the program started, the study topic ideas came from a number of sources. We read local newspaper articles and heard from scientists who gave presentations to the class. After about three years, individuals and community groups began to approach us with concerns that would especially benefit from data collection and analysis.

When teachers follow a question, we ask "how does this study reinforce the learning outcomes for our courses?" We also consider the long-term value to students after they graduate and the subsequent educational and employment doors that could be opened to them by participating in a particular study. In the curriculum of British Columbia and the Yukon, students require a two credit applied skills program, a two credit fine arts program and a physical education course in order to graduate. The applied skills program was developed to use environmental monitoring tools that complied with existing protocols. The fine arts program focuses on scientific illustration of biological organisms and landscape features using a variety of media. Among the range of opportunities provided by the grade 11 Physical Education course, was an introduction to marine environments that included a scuba diving certification. In total, the twenty credits that our students receive in this one semester program, provides them with considerable flexibility when making subsequent course selections.

The ES11 class has conducted a variety of forestry studies in the Haines Junction region. After discussions with the Alsek Renewable Resource Council, they asked the class to study the growth rate of the local forest and the impacts of a Spruce Beetle infestation. In one area, we tagged and monitored the growth of more than a thousand planted seedlings. We recorded natural seedling growth in mature forest stands and the regeneration in burn stands. We noted the growth and health of seedlings in a variety of cut blocks. Our seedling analysis was conducted in conjunction with the *Forest Structure Analysis Protocol* as outlined by the Foothills Model Forest. We also studied the growth rate of the mature trees in the area, taking more than two hundred core samples along with tree height and diameters for local white spruce.

Over a five year time span students made presentations to the Yukon Forestry Council. On one occasion, three young women faced a panel of eight unsmiling men who

wanted to promote more active logging in the area and did not want to hear the results of their analysis. The next day they made the same presentation to a public forum at the local college to considerable acclaim. Fifteen years later, they all work in the field of environmental monitoring and still have vivid recollections of their presentation to the Forestry Council. Their forestry-related presentations to the Alsek Renewable Resource Council led to a seven fold decrease in the annual allowable cut within the region. As one student noted at the time:

> *"One of the things I learned from ES is that everyone has a voice; it's all about how you say what you want to say. One of the most important things is to learn about the matter yourself and not rely on what others (e.g., pamphlets, protestors, etc.) are trying to convince you of. Do your own research, learn about it and you will have a stronger voice for it. People are more likely to listen to a knowledgeable person than a passionate, one-sided rant. And you might learn something yourself that changes your view of what others are saying. Being open to other people's opinions is as much a part of having a voice as knowing what to say."* (1998)

These examples of placed-based activities within the ES 11 program demonstrate the rich opportunities for applied academics, community involvement and the growth of responsible citizenship. They show that such activities often lead to unexpected areas of study, involve scientists who work in parallel with students and require team work to address unresolved problems. Such circumstances were seen as opportunities and fertile ground for student engagement. As another student recounted:

> *"Interestingly enough the barnacle survey completed at Coffin Cove (Ladysmith, BC) where the ES class was PADI certified and various beach surveys conducted on the same trip were likely the most relevant experiences I received for what would later become my career path related to statistical analysis, habitat surveys, data collection, scientific method, etc."* (2000)

From 1995 to 2010 ES11 classes studied the spruce bark beetle infestation in the Kluane region. With one adaptation, classes used the protocol developed by Canadian Forest Services to study a 100 meter transect through an area that had only been subjected to a walk through survey. The protocol measures only trees greater than 17.5 cm DBH (diameter at breast height) within five meters of the line and plots and records each tree by size and infestation condition. This is where we extended the protocol, counting all trees with a DBH greater than five centimeters. ES11 classes identified the infested stands, set out parallel 100 meter survey transects 50 meters apart. They counted all trees within the plot gaining a better representation of the forest ecology. Over the past 15 years we have assembled and studied more than eighty 100 meter transects. Students periodically took bark samples of infected trees, identifying counts of larva, adults and pupa stage bark beetles. The results of their more sensitive studies differed with those done by Yukon Forestry.

What are the long-term effects on student achievement and citizenship of making place-based activities a central organizing principle of a course such as ES 11? Insights were provided by two studies that followed ES11 students for ten years after they graduated from high school. Former students described the significant role this type of educational experience has played in their subsequent life choices. Most felt a sense of social and environmental responsibility – just the values and attitudes needed to address issues such as climate change.

> *"My educational experience shaped my long-term employment goal to be part of an organization that promotes global sustainability, environmental awareness and social conscience while building networks between governments and civil society. Ultimately, it reinforced my interest in development studies with a focus on environmental issues."* (1999)

How has this approach affected educational, environmental and social outcomes? Two long-term studies are currently underway to examine the impacts of this program 10 to 20 years after students left high school. To date, data from the two studies shows positive, complementary results. Those participating in the ES11 program demonstrated an uncommon level of engagement and civic and environmental responsibility.

> *"Volunteer service is an essential aspect of being part of a community. It is an important consideration in how someone chooses to live because to be a volunteer encourages people to pursue activities they are passionate about; it also encourages people to be increasingly aware of issues outside their own social circles; and provides the opportunity to foster attributes like commitment and dedication. With such attributes, volunteers ensure sustainable programs that address local issues and needs. I helped the Conservation Society of Sierra Leone facilitate community outreach workshops to encourage increased awareness of environmental and conservation of natural resource issues. I organize and conduct rapid assessment surveys of coastal sea-turtle habitat and local fishing practices."* (1999)

These students refer to the challenging and significant field studies, the co-operative work relationships that develop during their semester and the diverse instructional processes used throughout the program as features that left lasting change.

"After being in ES and after having gone through a moderate amount of post-secondary education I think that experiential learning is a more robust way of learning and teaching. Being able to see a medial moraine, a U-shaped valley, the impacts of clear cutting, etc., turned 'learning objectives' into concrete lessons. I think that in a perfect world all curriculums should/would be delivered in the same manner: intensive, tactile and above all meaningful." (2004)

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Of course, field studies resonated most with those students who learn best experientially and in social contexts. Students consistently reported the short and long term benefits attributed to their participation. A number of students indicated they struggled with conventional classes yet found success and engagement in the environmental field studies approach to courses.

"Innovative experiential programs like these are an excellent model and should be expanded into other regions of Canada and other subject areas – perhaps in physics (engineering) and political/social studies? Decisions on where to move with my family and where to enroll my child for school will be heavily influenced by the availability of programs such as ES." (1995)

The three examples outlined above and the student comments made years later, speak to the benefits associated with this approach to education. There are challenges associated with establishing programs that differ from the conventional high school science programming. Students' long-term outcomes speak to the value of such an approach. Over the past 20 years six different teachers have taught ES11. All feel the approach has changed their instructional practices for the better and all speak to the benefits of such an approach. Past students and their parents collectively see such programs as positively transformative. The efforts and commitments required of all ES participants are seen as well worth the effort.

"Motivated, engaged and challenging teachers with an awareness of current events reinforced my interest in global politics and encouraged my interest in development studies and sustainable communities…it had a lasting impact on my decision to pursue an education that included an environmental component." (1996)

Bob Sharp has held many educational positions in Yukon Education, starting in 1968 as the principal of Ross River School. In 1994, Bob created the ES 11 program and remains an active contributor to it.

Resources

The following may provide teachers with resources useful for starting their own experiential program. Many examples are still under development.

www.experientialscienceprojects.weebly.com
www.cowleylake.weebly.com
http://es11.weebly.com/