

# A Rewarding Partnership

*Critical components of a successful collaborative scientist–student project*

— Cheryl Abbott and Marc Swanson —

A collaborating scientist—a rewarding addition to any high school science program—can help students collect and analyze data that either replicates or parallels the work of the partnering scientist. This type of partnership is beneficial for both students and scientists, and perhaps there has never been a better time to consider such a collaborative project. Many scientists receive funding for their research from the National Science Foundation (NSF). Although NSF has always encouraged such partnerships, future NSF funding is placing a stronger emphasis on scientists addressing the “Broader Impacts” of their projects, such as including an educational outreach component (NSF 2004). The time is ripe for teachers to consider adding this dimension to their existing programs.

A perfect example of a scientist–student collaborative project is a program developed by University of Alaska Fairbanks geophysicist Martin Jeffries. Jeffries studies the growth of lake ice to understand how the ice thickness and conductive heat flow through the ice respond to climate variability and change. Jeffries has developed a program called the Alaska Lake Ice and Snow Observatory Network (ALISON) to give students the opportunity to act as authentic field scientists, and to provide him with valuable data for his study. The purpose of this article is to examine the critical components of a successful collaborative scientist–student project and to refer to ALISON as an example of this type of partnership.

## **Connect with students’ everyday life**

The whole purpose of a scientist–student collaborative project should be to connect the classroom science with authentic applications. Students need to see that what they are studying relates to their everyday lives. If students understand the relevance of a given issue they



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**FIGURE 1**  
**Quantifying heat exchange.**

are studying, they are more likely to take ownership of their work. The results can be surprising and rewarding. Students who normally might not take much pride in their work become involved and excited.

Scientists explore authentic issues to discover real answers. Working with a scientist gives students the opportunity to investigate something they may consider “everyday normal” or ordinary (see “Finding a scientist,” p. 34).

What could be more ordinary or everyday normal to most Alaskan students than ice-covered lakes? Lake ice is a normal part of the Alaska winter landscape—it is an integral part of many students’ lives. Frozen lakes and rivers are used as transportation corridors; for ice-skating, snowmobiling, and hockey; and holes are drilled in the ice for an exciting, albeit chilly, day of ice fishing.

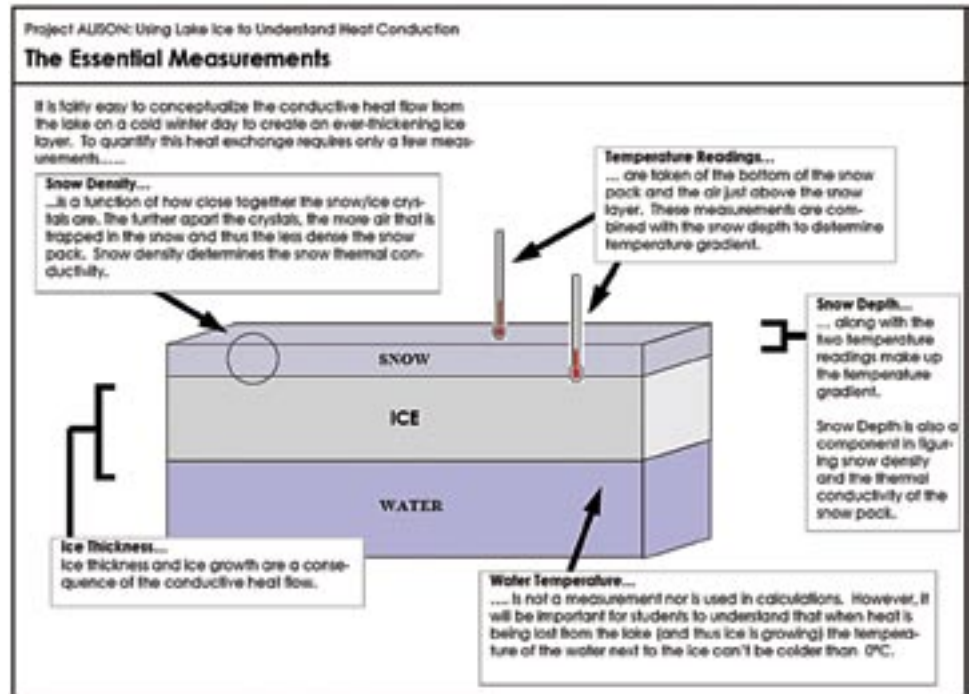
Ice, however, can be very dangerous. Knowing how to assess the ice thickness through subtle visual clues can be a matter of safety. Every year vehicles and lives are lost when people venture out onto thin ice. By studying lake ice, students learn skills that they can use the next time they take their snowmobile or skates out on the lake.

The benefits go beyond safety. By measuring ice thickness, snow depth, and density, and making various temperature readings, students soon understand the variables that are necessary to grow ice. They learn to apply the principles of thermal conductivity and heat flow to their local environment. Students begin to view the ice-covered lake as a reservoir of heat that is transferred to the atmosphere through snow and ice as water freezes on the bottom of the ice cover. They begin to make the connection!

**Students collect data**

Perhaps the greatest benefit to a collaborative project is the emphasis on effective and precise process skills. We have all been frustrated when students use sloppy data collection and recording techniques. Often this is because the data they collect is meaningless beyond one class period. When students are assisting or replicating a real research scientist’s data collection methods, their dedication to collecting accurate, meaningful data increases. Students know the data they are collecting is important and will be used outside their classroom.

The beauty of ALISON is that the measurements Jeffries uses are simple and easy for a wide age range of students to make and understand (Figure 1). On a weekly basis, students visit the lake to gather data on ice thick-



ALISON



(Above) A snow sampling tube of known cross-sectional area is used to obtain three snow samples. (Opposite) A hot-wire gauge is used to measure ice thickness. Safety note: Students and teachers must take extreme care when walking on ice.



**FIGURE 2**

## Heat and energy concepts.

Project ALISON: Using Lake Ice to Understand Heat Conduction

### Concepts: Foundations of the Formation of Lake Ice

**Concept #5: It requires a lot of energy to achieve a phase change with no change in temperature. This is called latent heat.**

We know that it requires an exchange of 1 calorie of energy to raise (or lower) 1 gram of water 1 degree Celsius. But in order to rearrange the molecular bonds to achieve a phase change it requires much more energy with no change in temperature. Try This!

**Resulting Graph**

Although the heat source remained constant, there was no temperature change until the ice fully melted. Then again the temperature topped out once the water began to boil. This illustrates the energy requirement (the latent heat) to change phases.

For 1 g water to go from...	Requires...
Ice to Liquid	80 Cal
Liquid to Ice	80 Cal
Liquid to Vapor	540 Cal
Vapor to Liquid	540 Cal

With no change of temperature

**Application to ALISON**  
Yeah, it takes a lot of energy exchange to cool down that lake. But to make ice...what!

**Concept #6: Heat does not pass through all substances at the same rate.**

Some substances conduct heat quickly, some slowly. Grab hold of two rods, one made of aluminum and one of wood. Then put one end of both rods into boiling water to see which one you'll have to drop first. This ability to conduct heat is known as a substance's thermal conductivity or insulating ability.

Examples of thermal conductivity are everywhere. We use this principle when we use a Styrofoam cup to keep our cocoa nice and foamy. Because heat passes slower through the Styrofoam cup, it will keep the drink nice and warm longer than the mug made of glass.

Snow can be a great insulator—but it is not the snow crystals that provide the most of the insulating value. No, it is the air that is trapped between the snow particles that has the insulating ability. Light fluffy snow—good insulation. Hard pack—not so good.

**Application to ALISON**  
That nice new blanket of snow covering your study site is just that...a blanket that restricts the flow of heat between the lake and atmosphere. The thermal conductivity of the snow is dependent upon the ratio of air to ice particles (expressed as density).

ALISON

information from ALISON are freely available at [www.gi.alaska.edu/alison/index.html](http://www.gi.alaska.edu/alison/index.html).] Jeffries also uses the data to run computer simulations of contemporary ice growth and the potential effects of climate change, such as more or less snow and higher or lower temperature.

### Align with science standards

More and more teachers are being asked to document how everything they do aligns with National Science Education Standards (NRC 1996). If there is not a strong connection, getting financial and administrative support is difficult. The good news is that behind every

ness, snow depth, snow density, and temperature. Back in the classroom, the amount of heat being conducted out of the ice and through the snow cover to the atmosphere is calculated using computer spreadsheets. This conductive heat flow determines the freezing rate at the bottom of the ice and thus the ice thickness.

The data is then submitted to Jeffries and within days students can view their data, and data from other ALISON sites, in graphical form on the project website. [Editor's note: Data, teacher guidebooks, and other

good research scientist is a lifetime of science experience and background. Their research is usually their life. After tapping into this wealth of knowledge defending the value of your project will be easy.

At first glance ice thickness would not seem to have much to do with any Standard. Jeffries visits our classrooms to initiate the project. He explains the value of the study to students and shows them how to collect the data. Jeffries' visit is followed by a unit on heat and energy that includes the topics of thermal conductivity, specific heat, latent heat, phase changes,

### Finding a scientist.

**Need some help finding a scientist to collaborate with? The following websites provide assistance.**

NSTA Teacher Resources:  
[www2.nsta.org/sciencesites](http://www2.nsta.org/sciencesites)

The Office of University Partnerships:  
[www.oup.org](http://www.oup.org)

The GLOBE Program:  
[www.globe.gov](http://www.globe.gov)

The National Student Research Center:  
[www.youth.net/nsrc/nsrc.html](http://www.youth.net/nsrc/nsrc.html)

The National Science Foundation:  
[www.nsf.gov](http://www.nsf.gov)

University of Alaska Fairbanks, Science Education Outreach Network:  
[www.uaf.edu/outreach/clearinghouse/index.html](http://www.uaf.edu/outreach/clearinghouse/index.html)



Students collect snow samples.

temperature gradients, and thermal resistance (Figure 2). (Visit the ALISON website at [www.gi.alaska.edu/alison/index.html](http://www.gi.alaska.edu/alison/index.html) for more examples like Figure 2.)

The NSES connection becomes obvious (see sidebar “Standard connections” for a list of content standards covered by the ALISON project). Students are doing more than taking measurements; they are learning the science behind the measurements through classroom and field activities. In the end, students view their frozen lakes as reservoirs of heat that can affect the climate.

One of the greatest aspects of the ALISON project is its flexibility. Some teachers use ALISON in their environmental studies classes to teach about climate change, while others focus on the physical science curriculum using the lake ice project as an example of heat and energy transfer (Figure 2).

Each partnership between students and scientists will be unique. The research may pull from any area of science, and thus cover many possible content standards. But the process of science will be similar. Students will be using appropriate tools to collect data. The ultimate goal of the data collection is to answer a scientific question. Students are experiencing scientific inquiry at its best, which is also addressed by the Standards.

Once the Standards are identified, the next step is assessing them. ALISON teachers can choose many possible assessment techniques, based on the appropriateness for their grade level and curriculum. Some teachers assess students’ abilities to take prudent lake ice measurements with an in-the-field performance exam. Heat and energy concepts can be assessed with model building or laboratory-based assessments. At the end of the season a large amount of data has been recorded from various locations around Alaska. Another assessment strategy requires students to explain, compare, and analyze data from two or more locations.

### Look at data

Because the any project such as this is collaborative, it is likely the project will end up with more than one data set. This may include students’ data, the scientist’s data, data from other study sites, and data collected during two or more years. This allows students to make comparisons, look for similarities and differences in space and time, look for variability or trends, and identify anomalies or data that just do not fit. Students get the chance to think critically and create conclusions based upon a larger data set. Students can also compare their conclusions with those of the actual scientist.

In the case of ALISON, student data are recorded at several school sites across Alaska. These sites range from Barrow (an arctic desert where frigid temperatures grow ice 2 m thick) to Seward (a maritime climate of heavy snows and midwinter thaws). This provides Jeffries with an abundance of data for his study and the opportunity for students to compare their ice growth to other sites with different climates. All of the data collected at

## Standard connections (NRC 1996).

Physical Science—Content Standard B (p. 176)

- Conservation of energy and increase in disorder
- Interactions of energy and matter

Earth and Space Science—Content Standard D (p. 187)

- Energy in the Earth system
- Geochemical cycles

Science and Technology—Content Standard E (p. 190)

- Understandings about science and technology

Science as Inquiry—Content Standard A (p. 173)

- Identify questions that can be answered through scientific investigation
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze and interpret data
- Develop descriptions, explanations, predictions, and models using evidence
- Think critically to make the relationships between evidence and explanations
- Communicate scientific procedures and explanations
- Use mathematics in all areas of scientific inquiry

the sites can be found on the ALISON website at [www.gi.alaska.edu/alison/index.html](http://www.gi.alaska.edu/alison/index.html).

In short, involving a scientist can provide an incredible opportunity for your classroom. With the right components, a scientist and a teacher can design a project that sheds new insight into what otherwise might seem to be an ordinary, everyday science phenomenon. The collaborative project can complement the curriculum while motivating students and benefiting both students and scientist.

With ALISON, the scientific and mathematical concepts that are introduced, learned, and applied throughout this unit have applications that extend far beyond ice-covered lakes and the cold toes that result from studying them. There is a group of Alaskan students that will never look at lake ice the same. And really, that is what science is all about. ■

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### Reference

- National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.
- National Science Foundation (NSF). 2004. *Grant proposal guide*. NSF proposal processing and review: Chapter III. [www.nsf.gov/pubs/gpg/nsf04\\_23/3.jsp#IIIA](http://www.nsf.gov/pubs/gpg/nsf04_23/3.jsp#IIIA).