



The Distant Exploration of Wolves

Using Technology to Explore Student Questions About Wolves

By Todd Campbell

Radio telemetry data available via the internet are used to facilitate long-term inquiry projects. Through these projects, students gain a deeper understanding of scientific inquiry and the nature of science, while developing their own questions and procedures and carrying out those procedures before sharing their findings with peers.

Over the course of human history, people have developed many interconnected and validated ideas about the physical, biological, psychological, and social worlds . . . The means used to develop these ideas are particular ways of observing, thinking, experimenting, and validating (AAAS 1993, p. 1).

Today's college students enter science classrooms having little to no experience with putting into practice the "particular ways of observing, thinking, experimenting, and validating" described by the AAAS (1993) and highlighted by McComas (2005) as central components of the nature of science (NOS).

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Windschitl (2003) went so far as to argue the following:

For a science student, developing one's own question and the means to resolve the question suggests an inquiry experience that is profoundly different from the far more common tasks of science schooling that consists of answering questions prescribed in the curriculum using methods also preordained in the curriculum or by the classroom teacher. (p. 114)

If students are to leave classrooms ready to assume the roles of individuals in a scientifically literate society as envisioned in *Science for All Americans* (AAAS 1989), experiences that promote students' understanding of the tenets of the NOS must be provided within the secondary and post-secondary science classrooms. When introducing

the key ideas relevant to understanding the NOS, there are two important factors:

- Science demands and relies on empirical evidence.
- Science is a highly creative endeavor. (McComas 2004)

As a university science educator working with instructional technologist graduate students in a class focused on integrating technology into science instruction, I, like many other college science faculty members, made teaching the NOS a priority. I also accepted the charge to facilitate instructional technologists' integration of technology into science instruction in a manner consistent with calls from standards documents.

The National Science Education Standards (NSES) and the American Association for the Advancement of Science (AAAS) both emphasize student inquiry as a central strategy for science instruction in the classroom (AAAS 1993; NRC 1996). In determining how to best teach about student inquiry and the NOS, I chose to provide opportunities for the instructional technologists to conduct their own open inquiries and to focus on linking these experiences to their own methods for integrating technology into science instruction. This decision mirrors decisions made by science methods instructors in pre-service teacher education programs (Windschitl 2003).

This article details our journey in an effort to offer ideas for adaptation, not adoption, of this project into undergraduate college science courses for science or nonscience majors, so that these students learn more about the scientific enterprise and the NOS.

Method

This project began at the beginning of the semester when students were told that they needed to complete a long-term, ongoing inquiry project. All students were asked to purchase a map of the Superior National

Forest from the International Wolf Center in Ely, Minnesota at www.wolf.org/wolves/experience/telemsearch/mapinfo.asp. During the second week of the semester students were introduced to the International Wolf Center website at www.wolf.org/wolves/experience/telemsearch/vtelem/telem_intro.asp. This site offers information about wolves ranging from wolf basics to scientific information and abstracts. It also offers specific information about the approximately 170 wolves inhabiting the Superior National Forest, including each wolf's sex, age, weight, pack associations, and the current status of the wolf, as well as radio telemetry tracking data dating back to 1971. Using this data and the map of Superior National Forest, the wolves' movement can be tracked across the forest.

As students became familiar with tracking wolves using the radio telemetry data and their maps, they were asked to develop questions that could be answered using the available data. During week three of the semester, students chose a guiding question from their list to aid their research. After selecting their guiding questions, students were asked to ensure that the question chosen was ready to be answered through investigation. Llewellyn (2002) described this type of question as one that leads to the collection of empirical data that can inform an explanation developed to answer the question. After the questions were finalized, students developed the procedures that they would employ and a timeline detailing group member responsibilities that would allow for the collection of data and formulation of a plausible explanation prior to the Wolf Research Symposium held during the final class (week 12) of the semester. Throughout the remainder of the semester, students were given 30 minutes to an hour of our three-hour meeting time each week to work on their

project. During this work period, much time was devoted to having students share their progress with peers and myself to ensure that each group was moving toward the successful completion of their project. This was not downtime for me as an instructor, but a time when I experienced the most meaningful interactions with students. I was busy "guiding students in active and extended scientific inquiry . . . providing opportunities for scientific discussions and debate among students . . . [and] continuously assessing students' understanding" (NRC 1996, p. 52), all teaching practices advocated in the NSES.

The final product expected from each group was an 11-slide PowerPoint presentation. Within the 11 slides, groups were required to share the following:

- Their guiding research question
- Their procedure
- The data they collected
- A graph or chart of their data
- Their conclusions and/or explanations
- Reflections on the investigations (changes in thought, new questions, and so on)
- References used in framing their research question in current literature

At the Wolf Research Symposium, each group was given 10 minutes to present their research followed by 5 minutes for peer questions.

The following closely chronicles the circuitous routes of one of the groups of students as they completed their project. The article concludes with a brief summary of other groups' projects and reflections.

A close chronicle of one group

As a group of three students began exploring questions of interest, one of the group members recorded the process, stating, "My question of interest is: What is the history of human interaction with wolves and how has this affected their population?"

Working with SI is quite helpful and informative; he has done nice research on the topics of wolves and the food chain, dealing with climate, different species, and human interaction.” Students spent time researching their early questions and found the following:

- In small towns men claim that wolf packs kill their livestock and trophy elk herds. Hunters and ranchers shoot wolves on sight outside of protected areas (Arandale 2004).
- The lack of human presence remains the most important variable in predicting wolf viability (Jedrzejewski et al. 2000).
- Where wolves and livestock coexist, only a small percentage of livestock losses are attributable to wolves. Most cows and sheep die of disease, weather, attacks by dogs, or abandonment (McNamee 2003).

As a result of their interest, the literature that seemed to signal a need for a better understanding of the impact of humans on wolves, and the data known to be available, students decided to study the following research question: Does the death of a wolf pack member by a human alter the traveling pattern of the pack? This group’s research procedure had them identifying the tracked wolves killed by humans, identifying associated wolves that were also being tracked, using the Superior National Forest map to plot out the traveling patterns of tracked wolves before death, and plotting out the traveling patterns of associated wolves prior to and after the death of the original killed wolves. The group completed this procedure for three different wolves associated with wolves killed by humans (Figure 1).

Through this research the group concluded that there were “insuffi-

cient data for a definitive answer,” but they did make two follow-up statements:

- The slight change in traveling pattern is not enough to determine cause.
- The associate wolf pairing with a new associate suggests survival is more pressing than the fear of humans.

When presenting their findings to the class, students were required to offer some reflections on their project. This group provided the following bulleted statements:

- Original question: “How does changing a wolf population affect the population of other species?” Too hard to find concrete data.
- Sparked interest for more specific data.
- A little disheartened that concrete answer was not found. But hey, that’s science.
- More curious about traveling patterns in relation to age and gender.

As students shared their final reflections on the project, their curiosity as a result of their experience reflected Rescher’s (1982) description of engagement in scientific inquiry whereby it “produces sequences within which the answer to our questions ordinarily open up yet further questions.”

Other group projects and reflections

All students in the class worked in groups of two to three to complete their projects. The following are the research questions studied by the other groups in the class:

- During a 12-month period, what percentage of time were wolves spotted in each of these four types of habitat variations: (1) forest land near water (wet), (2) dry forest land, (3) grassland near water (wet), and (4) dry grassland?

FIGURE 1

The traveling pattern of one wolf prior to and after the death of an associate. (The purple line represents travel prior to the associate’s death, while the blue line represents travel after the associate’s death.)

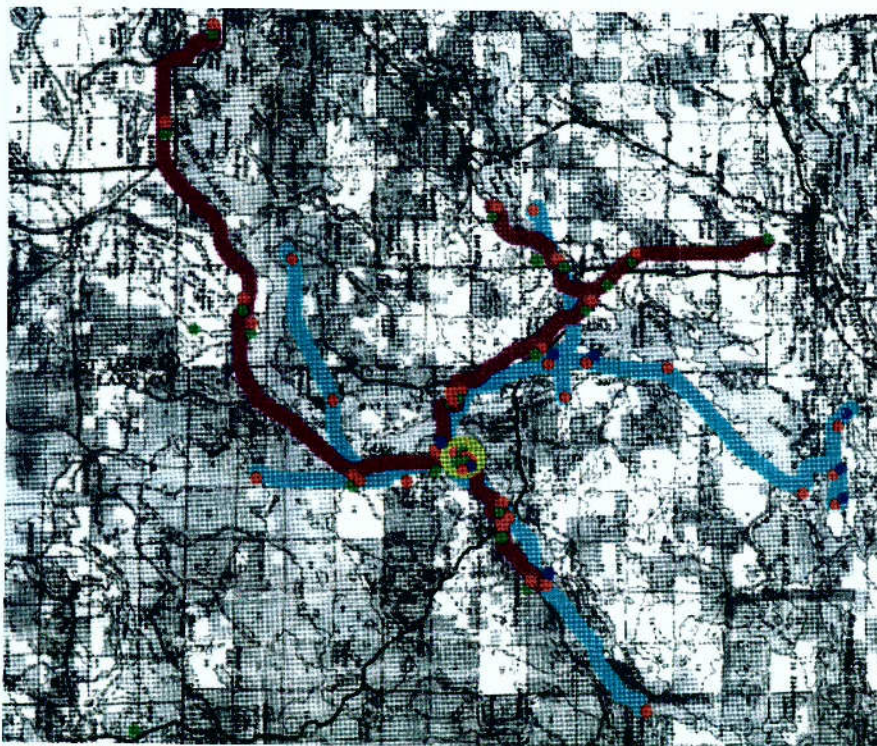
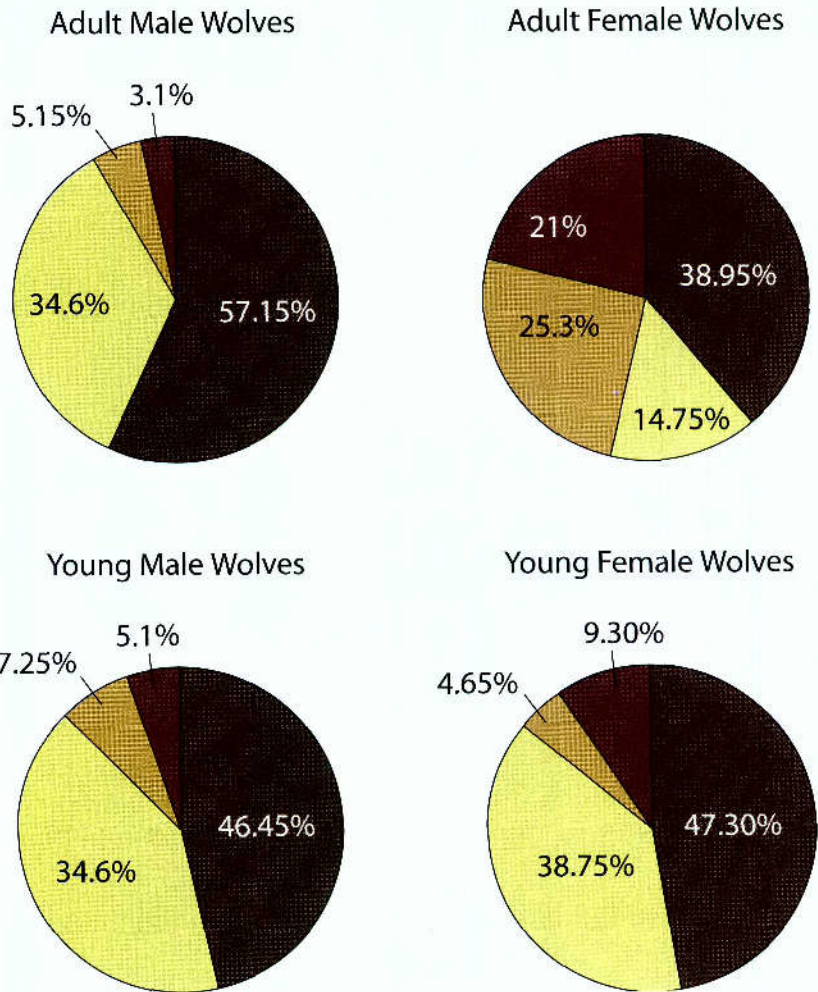


FIGURE 2

Percentage of time wolves spent in four variations of habitats.



- How does the alpha wolf's social structure compare to the alpha human male's?
- Does having an associate wolf affect travel direction, patterns, or behaviors?
- What percentage of wolves that travel 30 miles or more to find a mate actually succeed in their mission and settle down?

The group looking at the percentage of time spent in the four variations of habitats developed the following procedures:

- Searched wolf tracking database for viable wolves (two adults and two youths of each gender) during a period of 12 months
- Researched the missing labels for the map
- Plotted each wolf for a minimum of two data points per month

The group organized the data emerging from carrying out the procedure into tables and charts. The charts can be seen in Figure 2.

Through this work, students in the group concluded, "More wolves prefer to live near water compared to dry lands: 58.1% near water,"

FIGURE 3

Venn diagram comparing alpha male wolves to alpha human males.

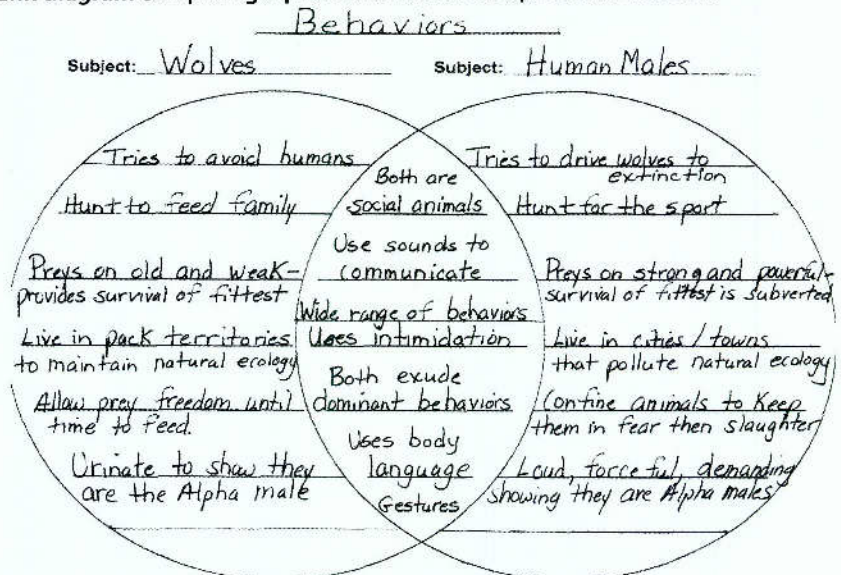


TABLE 1

The grades 9–12 NSES inquiry standards (NRC 1996, p. 175–76) and nature of science standards (NRC 1996, p. 200–201) met through the Distant Exploration of Wolves Project.

NSES 9–12 inquiry standard	Summary of implementation of standard in project
Identify questions and concepts that guide scientific investigations	Groups of two to three students developed their own testable questions to explore about wolves and procedures that would allow data to be collected to answer the questions.
Design and conduct scientific investigations	Students designed and carried out procedures in collecting data to answer their questions.
Use technology and mathematics to improve investigations and communications	Students used radio telemetry data available on the internet to facilitate investigations along with graphs and charts to communicate their results.
Formulate and revise scientific explanations and models using logic and evidence	Student inquiries culminated in the formulation of an explanation. This explanation was developed through group members' use of evidence, logic, and their understanding of the scientific knowledge inherent in their projects.
Recognize and analyze alternative explanations and models	Students reviewed current scientific understandings associated with their research and weighed the results of their findings in light of these understandings in formulating plausible explanations.
Communicate and defend scientific arguments	Students communicated the results of their research through PowerPoint presentations at an end-of-semester Wolf Research Symposium.
Science as a human endeavor	Students began to see how they could contribute to the scientific enterprise through the findings emerging from their research. They expressed fascination with their projects and experienced the ethical traditions of peer review and the transparent reporting of their research methodology and their findings.
Nature of scientific knowledge	Students presented their best possible explanations based on findings derived from empirical results and logical arguments. They experienced changes in their scientific ideas as evidence was collected that sometimes contradicted their original assumptions.

and “More wolves prefer shaded regions compared to grasslands: 79.8% in forest.”

The group that decided to study the alpha wolf's social structure compared to the alpha human male's took a more qualitative approach to their research. They compared literature detailing the interactions of alpha male wolves with qualitative data they systematically collected observing alpha human males in their natural environments. In the end, the group developed a Venn diagram of their findings (Figure 3).

Inquiry standards addressed and student outcomes

The NSES inquiry standards and NOS standards and how they are met through students' distant exploration of wolves are outlined in Table 1.

Postings contributed by students to a course weblog were used to determine whether student outcomes emerging from the inquiry experi-

ence aligned with the intended goals of better understanding scientific inquiry and the NOS. The following contributions indicated that students were gaining a more accurate understanding of science as a human endeavor and the NOS:

In working on this wolf project, it's been quite an amazing journey. I'm going to try hard not to give it away but S1, S2, and I created a hypothesis that the lifespan of wolves were around 12–15, based on the research and websites we looked at. (Boy. There were about 12 of them.) But we found out in some areas, this was definitely false.

At first, I found it frustrating to try to come up with a research topic. My partner, S1, and I had to revise our question several times before we came up with a question that was researchable without being over-

whelming. During this stage of the project, I was incredibly anxious.

The student in the first contribution is found articulating a belief that his group can contribute to the science enterprise, a realization that resonates with science as a human endeavor. The second contribution further illuminates science as a human endeavor, while also displaying an understanding of the NOS through recognizing that experimental results will be held to certain criteria that the student felt her group was meeting only after making revisions to their project.

Students' understanding of inquiry was also enhanced as can be seen in the following weblog contributions:

In making a connection between the wolf tracking project and my own classes, I realize that finding a research question is difficult for my students as

well. It takes practice to develop good, thought-provoking questions.

Will there be any consistent behavior among the wolves that have an associate wolf? As we printed out the information about the wolves during the time span selected the wolf did not always have an associate wolf. Why???

For those that do have an associate wolf most wolves only had an associate wolf for seven out of the consecutive sightings we chose. I wonder if this will affect our results.



I have the following questions about our project:

- ♦ Is there any significance to what we are doing considering the extremely small sample size?
- ♦ How accurate is the information on the wolf site we are using? When I look at the tables of data I see many blanks. What does this mean?
- ♦ Are there other factors that will affect our conclusions?
- ♦ Is our method of plotting the most effective?

These weblog contributions reveal students' understanding of scientific inquiry as they:

- ♦ illuminate the importance of research questions, as in the first contribution,
- ♦ grapple with designing and conducting investigations, as in the second contribution, and
- ♦ consider alternative explanations, as in the third contribution (NRC 1996).

Conclusion

Throughout my facilitation of these long-term inquiry projects, I kept

a journal of my own reflections about this process. At one point in the semester, I stated:

As we transitioned into the wolf project work time, this is where I felt the classroom come alive. It seemed students moved away from playing the game of education to critical thinking, struggling, sometimes expressing uncertainty, looking to me and peers for guidance, and occasionally asking for confirmation regarding the directions they were taking. In this time devoted to the project, students were engaging in science and perhaps getting a better glimpse at its true nature than could ever be gleaned from a lecture or even a discussion.

As I look back at what students learned during the semester, I refer back to the tenets of the NOS offered by McComas (2004). Just as science requires empirical evidence, these students were engaged in the collection and presentation of results based on empirical evidence. Through the many different studies that were designed, it can be seen that they were able to experience how creative science can be. Can experiences like

these be integrated into college science courses for major and nonmajors? I believe they can and I believe they need to be to meet the calls put forth in the national standards document (NRC 1996). ■

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