Cougars, Curriculum, & Community

A PBL curriculum provides students with valuable interdisciplinary learning experiences.

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On the eastern edge of the Cascade Mountain range in Washington State, high school biology students have a unique opportunity to study the elusive cougar (*Felis concolor*), a large cat native to the area. Nestled in the Cascade foothills is the city of Cle Elum, a small rural community that is expected to soon experience considerable growth from development of a large resort. The community provides an excellent model for scientific study of native animals; students can study and compare the cougar's habitat and behavior before, during, and after resort development. Cle Elum provides a unique context for determining the potential impact of human development on cougar habitat and behavior.

From an instructional perspective, the study of cougars provides an ideal way to engage both introductory and advanced biology students in interdisciplinary science inquiry and problem solving. Cougars are fascinating creatures and most students are naturally interested in learning about them. When faced with a complex problem that threatens cougars, students try to find solutions that ensure the animals' continued health and conservation. In this article, we describe the design and implementation of the Cougar Conservation Project (CCP), a problem-based learning (PBL) curriculum that provided students and community members with valuable interdisciplinary learning experiences.

Cougars as a context for learning

To provide some context as to why we developed CCP, we first must explain Project Cougars and Teaching (CAT), an interdisciplinary cougar-based curriculum that is currently being integrated across the Cle Elum-Roslyn School District. Initial concern about increased human-cougar conflict led the Washington Department of Fish and Wildlife (WDFW) to fund a study of cougars across Washington State. As the WDFW ramped up for a multiyear study of cougars, the Cle Elum-Roslyn superintendent began brainstorming ways to integrate curriculum in grades Pre K–12 in her district. Having had experiences with cougars as a child, she was particularly interested in the plight of the cougar in her community. A coincidental initial discussion between these two parties eventually coalesced into the multifaceted partnership that is Project CAT.

Using the cougar as an integrating context, CAT provides Cle Elum-Roslyn students with opportunities to engage in authentic science inquiry. Activities range from nutritional analysis of elk bones to radio collaring of live cougars. Elementary-, middle-, and secondary-grade levels each investigate specific issues related to cougars and contribute to the overall understanding of cougar habitat and behavior.

At the secondary level, a select group of advanced biology students is allowed to help WDFW biologists track and collar cougars during the winter. While collecting real cougar data is important, student safety is the primary concern. Every precaution is taken; students discuss many aspects of cougars with WDFW biologists, learn how to behave properly around the big cats, participate in preparatory meetings prior to tranquilization and capture, and follow proper handling techniques to ensure student and cougar safety. Students are also trained to use collaring and measurement equipment correctly. Once a cougar has been captured, it is fitted with a GPS collar so that WDFW biologists can collect data. Using a variety of tools, students then analyze regional cougar movement and behavior to provide real answers through embedded scientific inquiry.

While this biology experience is excellent for advanced high school students, general biology students were not initially included in the CAT curriculum. That is why we set out to integrate the CAT curriculum into general high school biology courses. To accomplish this, we developed and implemented CCP according to the general PBL method described by Greenwald (2000). Sonmez and Lee (2003) also provide a useful overview of PBL.

Integrating cougar conservation

The purpose of CCP is to help integrate CAT into the general biology curriculum, and to use this as a vehicle to foster authentic scientific inquiry while helping students become more involved in their community. A Central Washington University (CWU) preservice teacher designed CCP to coordinate the project with a genetics unit taught in three sections of general biology. Unit planning allowed sufficient classtime so that students could conduct research and construct a plan of action. The following steps describe the implementation and assessment of CCP.

Step 1: Encountering an ill-defined problem

First, CCP requirements (Figure 1) and performance evaluation criteria (Figure 2, p. 30) were outlined for all general biology students (primarily freshman and sophomores with some juniors) in the district. An intentionally unstructured genetics bottleneck scenario was presented to students, which resulted in some distress because it was not prescriptive. To help provide some structure, a few conservation scenarios were described as examples. Using the initial bottleneck information, students would have to research CCP and organize a plan of action that would increase community awareness. Students would also have to present their final action plan to classmates and WDFW biologists.

As a class, we briefly discussed genetic bottlenecks and brainstormed the implications a bottleneck might have on local cougar populations. Through facilitated open-ended discussion, students began to define the ill-structured problem by suggesting that factors such as prey density and habitat destruction might affect cougar populations.

Step 2: Prioritizing and investigating

Next, the class was divided into research teams of two to four individuals who worked collaboratively to research genetic diversity and cougar behavior. Using class discussion as a starting point, each team began to further define the cougar conservation problem. Research teams, realizing that there was a general relationship between the amount of available local land and the number of cougars, began to focus on methods to determine cougar carrying capacity.

Students also had to identify and evaluate sources of information (e.g., the internet, books, journals, and WDFW biologists) as part of their research. This step took considerable time because research teams had to compete for limited library and technology resources. This problem was partly resolved by using small groups; by reducing the number of people who were simultaneously accessing information, it was possible to move the entire project forward.

Step 3: Determining a best solution

Once research teams collected their information, they had to collaboratively determine a viable solution for cougar conservation. First, students had to evaluate the usefulness

FIGURE 1

Cougar Conservation Plan requirements.

"What happens when cougars—who need individual ranges up to 160 km^2 for their survival—are confronted with a booming human population? Where do North America's largest native cats go when their habitat gives way to hundreds of new houses?"

We need a plan, one based on your own knowledge of genetics and biodiversity. In the next few weeks, you will be learning about DNA, heredity, genetic variability, and much more. You will put your knowledge and research skills to the test by making a Cougar Conservation Plan for the Cle-Elum area.

The current population of cougars has been dramatically reduced in numbers, something that is called a "bottleneck." We need to work fast and come up with a plan to help the cougar population regain numbers. Your job is to come up with a genetic plan of attack. You will research, write, and present your plan that is worth 100 points toward your grade and will possibly be submitted to WDWF biologists. Good luck!

Research paper requirements:

- Groups of two to four students
- At least two pages, double-spaced
- Must convince the teacher that your plan is best for both humans and cougars
- Must be researched (e.g., using the internet, journals, and books)
- Must have at least three sources
- Must have a reference page
- Must contain valid reasoning as to why you believe your ideas are the best

Brainstorm ideas:

1. ____________________

2. ____________________

FIGURE 2

Cougar Conservation Plan evaluation rubric.

Points possible	**60**	**40**	**20**	**0**
Paper				
Length/ specifications	Over 2 pages, double-spaced, size 12 font, normal margins, cover sheet, small heading	1 ½ pages, double-spaced, size 12 font, normal margins, cover sheet	1 or more pages, size 12 font, normal margins	Less than one page, larger than 12 font, increased margins, no cover sheet
Content	Sufficiently researched, addresses cougar/human problem, has genetic reasoning, is convincing	Includes research, not all problems are addressed, has no genetic reasoning	Includes some research, poorly stated plan of action, is not convincing	Plan of action not researched, does not address the problem
Community outreach	Each member of the group created a sample of their community outreach	Most (75%) of the group created a sample	A few group members created a sample	No samples of community outreach
Bibliography	3 or more sources, properly referenced	3 sources incorrectly referenced	Less than 3 sources referenced	No references
Points possible	**20**	**15**	**10**	**0**
Presentation				
Length	5–10 minutes, organized, covered all aspects of their plan, community outreach, includes artwork	4–5 minutes, covered plan of action, includes artwork	2–3 minutes, roughly discussed plan of action, no artwork	2 minutes or less, did not communicate appropriately
Style	Used suitable technology or other resources, talked toward audience, engaged listeners	Used suitable resources, talked toward audience	Did not use suitable resources, did not talk toward audience	Were not prepared, talked toward the board
Participation	Rate each member of your group on a scale of **1–20**			

of their findings and combine their best information into a preliminary set of recommendations. Each research team's recommendations were then collected into a coherent plan of action and publicly presented to school and community stakeholders. To improve their cougar conservation efforts, research teams consulted successful conservation plans from around the world. By comparing their work to that of conservation experts, students could gauge their own skill and determine which specific factors contribute to conservation success. From their research, students developed global conservation awareness that they could relate directly to their experiences at the high school.

Step 4: Presenting conservation solutions

Consistent with Greenwald's PBL model (2000), each research team then communicated their plan of action publicly to their peers, WDFW biologists, Project CAT district leadership, and separately to the Project CAT coordinator, other teachers, and CWU faculty. In addition to research data, each plan of action included student cougar artwork that illustrated cougar body size and structure and provided visual context for research findings and conservation recommendations. For example, groups created trivia games, cougar pamphlets and flyers, or used computer software to create cougar animations. The interdisciplinary nature of CCP allowed students to integrate science, art, writing, and presentation skills while addressing an authentic biological problem that concerned the entire Cle Elum community.

Step 5: Debriefing action plans

To connect group action plans to the original genetics discussion and bring closure to CCP, each team had to explicitly address the problem of decreased genetic variability as originally presented in the bottleneck scenario.

For example, if one research team proposed to build a reserve enclosed with a fence, they had to include a genetics-based justification that showed how the fence would correlate with changes in surrounding cougar gene pools.

After their presentations were complete, students were asked to reflect on the overall process so they could explicitly connect their experiences to the steps of solving a problem. Students had to answer the question, "Did the plan of action address the conservation problem?" Finally, the whole class evaluated the collective pool of action plans to determine which plan had the greatest chance for success and increasing community awareness of cougar conservation.

Learning outcomes

Implementing CCP positively affected student learning in several ways. Student engagement, participation, time on task, focus, and interest all improved. While there is no definitive explanation for why student involvement and work quality increased, it is reasonable to suggest that the process of solving an authentic problem facing the community, working in small collaborative teams, and providing an interdisciplinary context effectively engaged students.

Being an integral part of the solution to the problem, students may have taken greater interest in the process and been more invested in the quality of the project's outcome. Many students spent a lot of time outside of class researching Cle Elum cougar populations by questioning WDFW biologists.

Small group learning may have also played an important role in learning outcomes. Small group collaborative learning has been well researched (Springer, Donovan, and Stanne 1999) and is thought to positively affect learning partly because peers at similar developmental levels construct knowledge through social interaction (Bruffee 1987; Johnson and Johnson 1985). By teaching others within their group, students may have reinforced their own knowledge about genetics and cougar conservation.

Inevitably, the question of how this PBL approach compares to a traditional genetics curriculum is raised. Traditional curriculum requires a basic knowledge of genetics, but how well the students learn genetics remains a significant question. Although not a scientific study, field observations from CCP support the notion that real student involvement and genetics learning came from addressing the authentic problem of cougar population decline.

Through inquiry and PBL, general biology students were able to provide some insight into the condition of the local cougar population and help determine how human encroachment might affect this population over the long term. Content coverage was comparable to the traditional genetics curriculum; everything from Punnett squares to cloning was discussed using cougars as the integrating context. Because students experience personally meaningful learning with CCP, it is possible they will carry this experience beyond the scope of this single general biology course. However, whether or not students actually learned more genetics with this approach will require scientific study.

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Practical considerations

Despite its apparent benefits, implementing PBL is not necessarily a straightforward process. Several factors must be considered to ensure success of this type of integrated learning (Van Scotter, Bybee, and Dougherty 2000). In this case, CCP was probably successful largely because it is a component of Project CAT, a districtwide initiative that receives considerable teacher and administrative support.

Prior to introducing the project, the effectiveness of CCP could have been improved with a small group work primer. Technology issues also need to be considered; for example, some students did not know how to save PowerPoint files to a floppy disc or other media.

A major strength of CCP (and the larger Project CAT) is its extensibility. The approach described in this work is not limited to the Cle Elum community and can be applied to the study of local organisms in communities around the world. Using the integrated approach of CCP, indigenous species can be studied and the same benefits provided for science, community, and student learning. By participating in authentic science, students may feel their learning is more relevant and meaningful to their own lives within the larger community. By using scientific skills and methods, students may also feel a part of the global scientific community. ■

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