BEAR CANYON ARROYO FIELD SURVEY:
GEOGRAPHIC FIELDWORK ACROSS THE SCIENCE CURRICULUM

by

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ABSTRACT

This project presents an interdisciplinary curriculum that merges geographic fieldwork and geospatial thinking with high school biology. The project addresses the need to integrate the diverse discipline of geography into subjects outside the social studies, in particular into science content. The curriculum also aims to demonstrate how field-based and place-based learning can be accomplished within the framework of a public high school’s block schedule, even given limited time and resources by utilizing campus and public open spaces. The project’s curriculum was implemented at the beginning of the school year with biology students. Students learned how to conduct a systematic survey, to explore the ecology of a local environment, and to create maps of field sites. The results of this curriculum project are evidence that secondary students are engaged with this type of learning and that they appreciate experiential lessons that convey both geographic and scientific concepts.
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CONTEXT

Introduction

The following is an analysis of a curriculum project developed in 2010 for a public high school biology class in Albuquerque, New Mexico. The aim of the project was to disseminate important geographic skills and thinking – specifically through the use of fieldwork, place-based education, and geospatial technology – in order to compliment and enhance a well-established science curriculum at the high school level. The curriculum developed for this project provides an example of how teachers and students of geography and science may come together to appreciate the interdisciplinary aspects of any subject, in particular geography and science.

Location

The project took place at Eldorado High School, a large (5A) high school that is one of fourteen high schools in the Albuquerque Public School district, located in central New Mexico. The enrollment at Eldorado is approximately 2200 students (70 percent Caucasian, 21 percent Hispanic, 3.5 percent African Americans, 3 percent Native American, and 2 percent Asian). Eldorado was an ideal location because of its proximity (a fifteen-minute walk from campus) to Bear Canyon Arroyo, a plot of open space in the northeast quadrant of the city that is managed by the City of Albuquerque. Bear Canyon Arroyo is an ideal site to study the unique fluvial ecosystem because of the diversity within the arroyo.

Curriculum Placement

While Eldorado offers courses in both geography and biology, the biology class provided a better venue for the content that this curriculum project aimed to address. Early in the school year, the biology curriculum map transitions from a unit covering the scientific method to one on scientific measurement and then introduces a unit on ecology. The project aimed to use fieldwork and land observations as a platform for implementing and interpreting scientific method and scientific measurement while setting the stage for the ecology unit. The project consisted of three class periods of instruction – one week’s
worth of class time – 1 hour 38 minutes the first day, 3 hours 30 minutes on the second
day, and another 1 hour 30 minutes on the final day for a total of 6 hours 36 minutes of
instruction.

History

In order to best understand the context of this curriculum project, it is important
first to understand both a brief history of geographic education as well as some
fundamental challenges that have arisen as a result. The value placed on the study of
geography suffered a real blow during the nineteenth century as the intellectual
specialization of knowledge accelerated (Gregg & Leinhartz, 1994, p.312). As a result,
the broad-spectrum study of geography that once existed was whittled down and
compartmentalized, largely to the detriment of geographic education. According to
Tuason, “biology, geology, meteorology, political science, economics, and anthropology
developed separate disciplinary identities, and consequently, geography seemed to be
stripped of its content, until all that was left was the study of regions and places” (1987,
as cited by Gregg & Leinhartz, 1994, p. 313).

During the twentieth century, educational policy-makers began to phase
geography out of the curriculum entirely, integrating it into the social studies curriculum
in order to better meet the needs of American students (Gregg & Leinhartz, 1994, p. 313).
But, “by its very nature, geography draws together information from many sources” (p.
314). Therefore, the merging of geography with social studies created a shortfall for
geography as a whole.

The geography that has been taught or learned opportunistically, rather than
systematically, has gaps in the conceptual framework, so much so that
it has been reduced to a rather trivial, simplistic, fragmented subject,
rather than presented as a powerful tool for reasoning and problem
solving. When geography appears in the curriculum only in relation to
history, sociology, or political science, for example, the same few
geographic concepts are taught over and over. As a result, the
geography content of social science classes is usually limited to low-
level, fragmented information about place names and descriptions
(Gregg & Leinhartz, 1994, p. 314).
The practice of integration also virtually eliminated physical and environmental geography from the curriculum. Those that supported the integration believed that the content of physical geography would be understood as students studied the earth in science class (Gregg & Leinhartz, 1994, p. 313). But, the fact remains that “even though physical geography and environmental geography focus on environmental science topics, they have been largely excluded from ‘scientific’ environmental disciplines, a fact that diminishes the public’s perception of geography” (James, 1969; as cited by Earl, Montalvo, Ross, & Hefty, 2009, p. 266). More recently, “state educational standards and the No Child Left Behind Act have prioritized reading and math as well as regular assessments” over other subjects (Perkins, Hazelton, Erickson, & Allan, 2010, p. 213).

The cumulative affect of this storied history is that Americans “view geography as an esoteric and/or archaic discipline, neither comprehending the value of such knowledge nor realizing that some understanding of it is essential to becoming a well-rounded, educated person” (Reinhartz & Reinhartz, 1990, p. 13).

**Importance of Geographic Education**

Actually, geography is incredibly important in helping us understand the world around us. “Geographic knowledge and skills are essential for us to understand the activities and patterns of our lives and the lives of others” (Grosvenor Center & National Geographic Society, n.d.). In fact, we use geographic skills every day to navigate and interpret our surroundings. As a result of modernization, “global, economic, cultural, and environmental forces increasingly shape our lives” (Grosvenor Center & National Geographic Society, 2000). This renders geographic skills and the study of geography ever more important for a student’s survival, success, and competitive edge once they complete their education. Acquiring geographic perspectives, information, concepts and skills also encourages students to gain a deeper understanding of global interdependence (Gregg & Leinhartz, 1994, p. 316), which is essential in the twenty-first century. In addition, “a strong education in geography opens the door to an expanding array of interesting jobs and careers” (Grosvenor Center & National Geographic Society, 2000). On an even more subtle level, “geography challenges citizens to become better environmental stewards” (Grosvenor Center & National Geographic Society, n.d.).
Thankfully, “along with the recent documentation of widespread geographic ignorance has come a desire on the part of educators, parents, and the business community to reintroduce geography, in one form or another, to the curriculum” (Gregg & Leinhartz, 1990, p. 314). So, the question becomes how to do so effectively in the context of our modern educational framework.

**Re-vitalizing Geographic Education By Teaching Across The Curriculum**

As we have already learned, geography has been divided and merged with social studies, and to a lesser degree, the earth sciences. Given that this curriculum practice is not likely to change without considerable effort, we will need to find ways to re-vitalize the field of geography within the interdisciplinary context that has evolved around the subject. One suggestion that has been made is to teach across the curriculum (Reinhartz & Rienhartz, 1990, p. 15) – not just in social studies classes, but to integrate geographic skills into as many subjects as possible.

Because “one aim of geography is to put back together what other sciences have taken apart” (Tuason, 1987, as cited by Gregg & Leinhartz, 1994), geography has an important place in any classroom where reductionist thinking drives the learning process. As Aristotle so famously said, “the whole is greater than the sum of its parts” and geographic thinking allows us to take an important step back and to consider a broader perspective or a more cohesive view of the whole. “The integration of geography into other subjects encourages students to organize their ideas into units that tend to fit into the whole fabric of knowledge; it also discourages fragmentation (Reinhartz & Rienhartz, 1990, p. 10). At the same time, the introduction of geography content provides a context for learning an entirely new skill set and broadens the horizons of the host subject. Herein lies the value of interdisciplinary education.

Social studies does, of course, provide a natural framework within which to teach geographic skills and geography content. However, as we have already seen, to teach geography in social studies courses alone eliminates important aspects of geography that no longer have a solid place in the curriculum. So, where else can we teach geography? According to Reinhartz and Reinhartz, “geography is often considered a science” (1990, p.57), and “geography can enhance the teaching of science” (p. 10). While geographic
content could be taught in a number of subject areas, the sciences – specifically the earth sciences – are the next most obvious arena within which geography can flourish. According to Earl et al. (2009, p. 266), “geography is the mother discipline for the environmental sciences by both its focus on the surface of the Earth and its integrative theoretical approach.”

Ecology, in particular, provides a wonderful host topic within which geographic concepts and spatial thinking can be effectively taught. “Ecology is the scientific study of the interaction between organisms and their environments (Campbell, 1993, p. 1052). Additionally, “we can think of ecology as the study of the distribution and abundance of organisms” (p. 1053). This language makes obvious the connection between ecology, geography, spatial thinking and environmental relationships. This is precisely why this curriculum project was integrated into a science class and specifically inserted at the junction between units on scientific method/measurement and ecology.

The Importance of Fieldwork

Another means of improving the quality of geographic education in the integrated framework is to incorporate as much fieldwork as possible. In fact, “fieldwork is perceived by many geographers as being at the heart of geography” (Gold, Jenkins, Lee, Monk, Riley, Shepard, & Unwin, 1991, as cited by Fuller, Edmondson, France, Higgit, & Ratinen, 2006, p. 90). Carl Sauer believes that, “the principal training of geographers should come, whenever possible, by doing fieldwork” (1956, p. 296).

To this end, ‘the field’ is defined as any place “where supervised learning can take place via first-hand experience, outside the constraints of the four-walls classroom setting” (Lonergan & Anderson 1988, as cited by Rice & Bulman, 2001, p. 3). Fieldwork should not be confused with field trips. Fieldwork dictates that students are directly involved in gathering the required information for the field project, whereas students on field trips are typically instructor-led and are passive participants. This is an important distinction because “learning activities such as fieldwork and project work, which are routinely incorporated into geography courses… can be regarded as experiential learning (Ives-Dewey, 2008, p. 167) whereas a field trip may or may not be.
From a philosophical standpoint, experiential education is “a process through which a learner constructs knowledge, skill and value from direct experience” (Association for Experiential Education 1991, 1, as cited by Ives-Dewey, 2008, p. 167).

This model, where students are given the opportunity to apply their skills and understanding while performing “real” research (Hall, Healey, and Harrison, 2002, p. 214 as cited by Cook, Phillips, & Holden 2006, p. 413), has numerous benefits.

“Traditionally fieldwork has been viewed as a good learning environment for reinforcing and developing areas taught in formal lectures or practical sessions” (McEwen, 1996, p.381), but fieldwork also serves to solidify specific competencies that are useful in their own right. “At the high school and undergraduate levels, fieldwork is important for developing in students the skills to be qualified practitioners in all aspects of geography” (Gold et al., 1991 as cited by Rice & Bulman, 2001, p. 7). “Fieldwork can also enhance a range of transferable skills such as communication and presentation skills, group and leadership skills, organizational and problem solving skills” (Rice & Bulman, 2001, p. 8). In addition, students learn how to “take responsibility for their own learning” (Hall et al., 2002, p. 214 as cited by Cook et al., 2006, p. 413).

It is important to consider, also, that a student’s exposure to experiential learning actually serves to enhance the impact of the overall learning experience. A 2005 study compared a group of sixth grade students exposed to experiential learning outdoors with a control group of students who remained in the classroom. The students who learned experientially demonstrated, “a 27 percent increase in measured mastery of science concepts; enhanced cooperation and conflict resolution skills; gains in self-esteem, problem-solving, motivation to learn, and classroom behavior” (Louv, 2008, p. 208).

While these benefits clearly demonstrate that experiential learning and the incorporation of fieldwork projects are worthwhile for students, secondary teachers are often intimidated by the perceived challenges of “risk, student behavior, cost, social inclusion and ‘red tape’” (Cook et al., 2006, p. 415). This curriculum project was developed with the intention of demonstrating that fieldwork can actually be incorporated into a traditional classroom curriculum with relative ease. It aimed to expose students to realistic geographic fieldwork but required only two days of instruction outside the classroom.
Local Landscapes Make Fieldwork More Accessible

It is also important to recognize that “fieldwork studies need not occur in faraway places. Rather, field studies can be developed that take advantage of a home city or local area, and thus ‘provide students with the opportunity to understand concepts in a landscape in which they are already familiar’” (Martin, 2003, p. 36, as cited by Lackstrom & Stroup, 2009, p. 79). Logistically, fieldwork that occurs in far-off locations requires arranging transportation for students and faculty. On the other hand, fieldwork done in more ordinary settings can be just as beneficial and serves to make field-based education more accessible by simplifying the logistics. Thankfully, trends in urban development have increased the number of such sites available to teachers and students. ‘Greenways’ or ‘riverwalks’ “are prominent features of many urban landscapes” (Lackstrom & Stroup, 2009, p. 79). Greenways are usually located in protected parks or open space areas containing public trails. They are often developed alongside riparian or wetland areas and provide a link between urban and natural landscapes (p. 78).

The field component of this curriculum project first utilized outdoor spaces on campus and later a local greenway in Albuquerque, New Mexico known as Bear Canyon Arroyo – a plot of open space within walking distance of Eldorado High School. Arroyos are common features of desert landscapes that are created by water erosion. They are intermittent stream channels that are a part of a larger drainage system and therefore eventually join larger arroyos, streams, and/or rivers. Bear Canyon Arroyo collects run-off from the adjacent 10,000 foot Sandia Mountain Range to the east and funnels the water through the urban landscape of Albuquerque toward the Rio Grande river. Bear Canyon arroyo offers flood mitigation for the City of Albuquerque and simultaneously provides a recreation area to the public. It is managed by the city’s Parks and Recreation Department. The arroyo is part of a larger network of land that contains 2,650 acres and is called the Sandia Foothills Open Space area (City of Albuquerque, n.d.). This curriculum project utilized Bear Canyon Arroyo with a larger purpose in mind: to demonstrate how truly accessible fieldwork and field-based research can be to urban high schools.
Geospatial Technology

The use of geospatial technology was another way in which the curriculum project aimed to improve the potential of modern geographic education. For the purposes of this paper, geospatial technology will be defined as the wide range of software and equipment, such as Google Earth, GPS, and GIS, used to locate and analyze spatial information. Because “geospatial technologies have emerged as an increasingly indispensable part of contemporary life, as well as serving as a crucial component of specialized applications in career fields that include science, social science, health, business, and engineering” (Nielson, Oberle, & Sugumaran, 2011, p. 60), the project aimed to expose students to its uses. Additionally, research has demonstrated that the use of such technologies “improve student attitudes, motivation, self-efficacy, and enthusiasm in support of geography learning” (Keiper, 1999; Baker & White, 2003; West, 2003, as cited by Nielson, Oberle, & Sugumaran, 2011, p. 61).

Of the geospatial technologies available for educational use, hand-held GPS units offer an advantageous introduction. They are readily available and they are commonly used to gather the preliminary data for more advanced applications of geospatial technology. From this perspective, when students become proficient with hand-held GPS units, they gain a real-life skill that can enhance their understanding of the geospatial technologies that they interface with on a daily basis. During the field component of this curriculum project, students used hand-held GPS units to navigate to their field sites, gathering latitudinal and longitudinal coordinates, and to collect elevation data for each quadrant they surveyed.
Lesson Summaries

Lesson One: GPS and Fieldwork Preparation

Before this curriculum project was introduced, students had been primarily oriented towards science content. This lesson integrated geography content into the science classroom, introducing concepts and equipment specific to geography. Students were made aware of geography’s contributions to science and how the two disciplines can work together. Thus, one of the main objectives of the project – creating an interdisciplinary curriculum that included geography – was set in motion.

The first lesson established a foundation of understanding for the entire project. The lesson began with the bellringer, “What is a survey?” Bellringers are thought-provoking questions aimed at getting students engaged with the topic of the day. The bellringer question is typically displayed at the front of the class for all students to see. Bellringers can be facilitated in two different ways: students can answer the questions individually in writing or they can discuss the question in small groups. Ideally, this routine of opening class with a bellringer is established at the start of the year.

After the bellringer, a PowerPoint presentation was given and students were introduced to the concepts of absolute and relative locations, the United States’ global positioning system, the geomorphology of arroyos, and two field survey methods: transect lines and quadrants. Students then used handheld GPS receivers to find several absolute locations on campus. Students recorded the latitude, longitude, and elevation of their each absolute location they found.

By completing this “GeoCaching” activity outside their classroom, another main objective of the project – to incorporate outdoor and experiential principles into the unit – was fulfilled. The comfort students developed using the GPS units prepared them for the fieldwork component that followed in lesson two.

This lesson addressed ninth through 12th grade: National Geography Standard 1, New Mexico Science Standard Strand I: Scientific Thinking and Practice Standard I with Benchmark I and Performance Standard 1. It also addresses three geospatial thinking objectives - location, condition, hierarchy. For a complete lesson plan, see Appendix A, page 23.
Lesson Two: Fieldwork

In this lesson, students performed interdisciplinary fieldwork in a nearby arroyo. Students learned how to set up a systematic collection grid and how to collect vegetation data, surveying three quadrants along a single transect line. Each of the eleven transect lines straddled the main stream channel of Bear Canyon Arroyo, north to south. Students used the GPS units to find the center of three quadrant locations along their assigned transect line: Quadrant A in the stream channel itself, Quadrant B north of the stream channel, and Quadrant C south of the stream channel. Quadrants B and C were all situated higher on the flood plain, outside the main path of the stream channel. Because the student surveys were meant to illustrate the difference between stream channel vegetation/plant distribution and floodplain vegetation/plant distribution, locations for quadrants B and C were chosen such that students would be able to observe the change in plant species and distribution outside the stream channel.

The below image details the layout of the transect lines and quadrants that the students surveyed.

Students were asked to create a site map, to calculate the number of grasses, forbs, cacti, and woody plants (four identified categories of plants) for each of their three quadrants and to record specific types of quantitative and qualitative data for each quadrant.
This lesson addressed ninth through 12th grade: National Geography Standard 1, 3, 4, and 8. Additionally, New Mexico Science Standard Strand I: Scientific Thinking and Practice Standard I with Benchmark I and Performance Standards 1, 2, and 3. It also addressed four geospatial thinking objectives—location, condition, comparison and transition. For a complete lesson plan, see Appendix A, page 27.

**Lesson Three:  Debrief of Fieldwork and Data Analysis**

During the final lesson, survey groups entered their vegetation data into interactive white board software. Students compared their data with other field groups. With all of the compiled data, students analyzed and compared the results with their initial hypotheses as to how severely the arroyo had been impacted by human activity. The instructor summarized the actual factors contributing to the day-to-day conditions of the arroyo. Students provided feedback on their experience of the project. This interdisplinary/transitional unit established an educational foundation that led seamlessly into a unit on ecology.

This lesson addressed ninth through 12th grade: National Geography Standard 1, 3, 4, 7, 8, 14, 15, and 16. Additionally, New Mexico Science Standard Strand I: Scientific Thinking and Practice Standard I with Benchmark I and Performance Standards 2, 3, and 4. It also includes Benchmark II and Performance Standards 1 and 2. Finally, New Mexico Science Standard Strand II (Life Sciences): Understand the properties, structures, and processes of living things and the interdependence of living things and their environment with Benchmark I and Performance Standards 1, 2, 3, and 4. Geospatial thinking objectives addressed: condition, connection, comparison, aura, transition, hierarchy, and spatial model. For a complete lesson plan, see Appendix A, page 33.
CONCLUSION

Student Results

When this project was implemented at Eldorado High School, the majority of students developed an appropriate level of comfort with the GPS units so that they were able to successfully navigate to their field sites during the field excursion. Once in the field, the level of detail and the quality of field data collected varied widely from student to student and from field group to field group. This variation was most evident in the student maps, the qualitative data sketches made by the students, and in the plant survey calculations made for each quadrant.

Student maps of their field areas reflected a broad range of attention to detail. Several groups of students produced a detailed map that followed the instructions and recommendations outlined on the sample map that was provided. Others took a bare minimum approach, showing only minimal landmarks and the three quadrants surveyed. Some maps did not contain legends and were somewhat difficult to interpret.

All student groups spent quality time surveying their quadrants, gaining an appreciation for the survey process. That being said, some groups were very careful and attentive to accuracy when counting plants while others made gross estimates. It was also clear that some students did not understand how to break down the five-by-five meter quadrants into smaller units (decimeters and centimeters) in order to more accurately calculate the total number of plants for the quadrant as a whole. As a result, the data quantifying the four different types of vegetation in each quadrant varied widely.

Seven of the eleven transect lines were surveyed by both first and seventh period student groups. Comparative data revealed significant differences along every transect line that was surveyed twice. For example, Table 1 below shows the number of forbs students in first and seventh periods counted for quadrants A, B, and C along transect line #4.
Table 1: Number of Forbs Counted in Transect Line #4 Quadrants

<table>
<thead>
<tr>
<th>Forbs Counted in...</th>
<th>Quadrant A</th>
<th>Quadrant B</th>
<th>Quadrant C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Period Survey</td>
<td>156</td>
<td>625</td>
<td>625</td>
</tr>
<tr>
<td>7th Period Survey</td>
<td>16</td>
<td>4</td>
<td>75,361</td>
</tr>
<tr>
<td>Difference</td>
<td>140</td>
<td>621</td>
<td>74,736</td>
</tr>
</tbody>
</table>

As soon as students viewed the graphs representing the collective student data, it became clear that the quantitative calculations the students made were too widely varied to reflect accuracy or consistency in the students’ methodology from group to group. These inaccuracies hindered the analysis of the data considerably.

The quantitative data was intended to paint a picture of patterns in plant distribution. Instructors had hoped to be able to look for broad patterns regarding the growth of grasses, forbs, cacti, and woody shrubs in relation to the stream channel. While informal observations regarding plant distribution were quite clear to students, there were not any clear patterns made evident by the data collected. These observations were therefore elucidated during a class discussion instead.

When it came to evaluating human impact on Bear Canyon Arroyo and how close it was to a “natural state,” student views generally changed as a result of the fieldwork. Prior to visiting the arroyo, most students hypothesized that the arroyo would be fairly close to its natural state with a small amount of impact. However, after the surveys were complete, the students had recognized a wide range of impacts on the arroyo system: the dam, nearby housing developments, drainages from the residential areas entering the arroyo, trails through the open space, etc. These factors were further clarified and discussed on the final day of the unit so that students could begin to make broader connections, even if they did not observe all of the noted factors of influence first-hand.

Student Learning

The student survey results (See Appendix B, page 47) provided clear insight into the many lessons students took away from this curriculum project as well as their level of enjoyment and engagement. In general, the students really appreciated getting outside the classroom, thought working with the GPS units was fun, and enjoyed learning the
survey process. Setting up plots and counting plants was the least-liked aspect of the project. While instructors saw a clear correlation between the project and a solidification of scientific method and measurement skills among students, the students themselves felt somewhat indifferent about how much the field project improved their understanding of scientific measurement. In their answers to the survey question: “what is the most important thing you learned,” students revealed what they most valued from the curriculum project. Among the responses to this question were the following:

- “how to navigate with a GPS”
- “nature has wonders, even in the desert”
- “how wildlife changes at different levels in an arroyo”
- “wear sunscreen”
- “to divide spaces using the metric system”
- “how vegetation differs depending on location”
- “need to bring water”

These answers were representative of a number of impactful lessons the students took away from this curriculum project. Ranging from ecological observations to the development of practical skills and insights into the need to be physically prepared for doing fieldwork, each student had a unique experience of this project. Students were therefore able to connect with different aspects of the learning objectives according to what (s) he found to be most valuable.

**Project Successes**

Overall, this curriculum project was a success on a number of levels. It allowed for a seamless integration of geography into the science curriculum – expanding the students’ grasp of geography and simultaneously enhancing their understanding of science. It also served as an important bridge between the unit on scientific method/measurement, which preceded the project, and the unit on ecology which followed it. The fieldwork component of this curriculum project gave students an opportunity to apply their understanding of scientific methods and measurement in a hands-on field setting. This reinforced the previous unit of study while instilling a new level of understanding around geographic thinking, skills, and field methods.
In a similar way, the curriculum project provided an enticing introduction to the unit on ecology. The fieldwork component of the project allowed students to see firsthand the complexity of relationships in the natural world as well as the importance of cause and effect in natural systems. This insight laid a solid foundation for studying the interconnections that would be further explored in the unit on ecology.

The field component of the project was quite doable because Bear Canyon Arroyo was an easy location to access. In addition, Eldorado’s block schedule made it possible to complete the fieldwork without requiring students to miss significant class time in other courses. In fact, each group of students missed only one class period of another course in order to complete the fieldwork component. Other teachers at Eldorado were supportive of this excursion and so the schedule adjustment posed no problems whatsoever.

The project also served an important role in establishing cohesiveness and a positive class dynamic toward the start of the school year. Fieldwork requires students to work together in ways that are not often required of them in the classroom and creates a unique opportunity for students to learn about themselves and one another. Many students expressed in a student survey that they learned something new about their classmates as a result of this curriculum project and that they felt like their field group had worked well as a team. From a teacher’s perspective, the project did an excellent job of bringing the students together.

**Suggested Improvements**

While the project was a success overall, there was plenty of room for improvement. The field component of this project was so essential that, for students who did not have a signed permission slip for the field excursion, this unit of study was very difficult to make up.

More significantly, the data collected by the students was flawed by a number of inaccuracies that made it very difficult to do any sort of meaningful data analysis. In the interest of avoiding this problem in the future, I would recommend the following changes:
1) **Add a lesson on vegetation counting.** Adding an activity that specifically addresses how to calculate vegetation numbers in a quadrant would improve the accuracy of the quantitative vegetation calculations data gathered. It would be fairly simple to mark off a vegetated quadrant on an athletic field or campus open space. The entire class could practice counting and calculating vegetation within a single quadrant so that students could compare numbers and teachers could better oversee the accuracy of the process. In this manner, students would be more prepared for the field excursion and better able to obtain accurate numbers and improved calculations of vegetation totals without direct supervision of teachers.

2) **Move the step-by-step instructions for the fieldwork to immediately precede the field excursion.** Students were given specific instructions for the fieldwork component of the project at the end of lesson one. However, this was problematic because students did not remember the specifics of the process by the time lesson two arrived. Therefore, it would be better to open lesson two with a brief introduction to the step-by-step field expectations, and then depart for the field survey immediately after these instructions are given. The information would therefore be fresh in students’ minds and they would be more likely to succeed in the survey process.

3) **Ask students to sketch a cross-section of their transect lines.** This task could be added to the fieldwork worksheet alongside the other steps required for the completion of the survey. Sketching a transect line image similar to that presented during lesson one would allow for a more direct comparison between the hypothesis the students formulated during the lesson two bellringer and their actual findings during the arroyo fieldwork. A sketch would also encourage students to look at the transect line as a whole rather than being singularly focused in on the specifics of the individual quadrants. In addition, sketching the transect lines would allow students to see more clearly any differences between the transect they observed and the view of an arroyo in its natural state that was presented in class prior to the excursion. The detail observed in the process of
making these sketches would also serve to strengthen students’ ability to participate in the analysis of results that is performed in lesson three.

4) **Add an activity assessing the big-picture impacts on the arroyo as a whole.** It would also be valuable to add an activity that required the students to assess the big picture of the arroyo and the numerous influences that affect its state of health. This would give students and even clearer appreciation for the level of impact on the arroyo and the degree to which it has been altered from its natural state. Without an explicit activity requiring students to take a step back from their transect lines and quadrants, some students failed to see the wide range of influences that impact the arroyo on a daily basis. Other students picked up on these factors simply by being out there, but a focused activity requiring a broader view would have made these influences clearer to more students.

**Usefulness to Other Classrooms and Teachers**

On the whole, this project would be fairly easy for other teachers to incorporate in their own classrooms. While the project did require some additional preparation time, it did not require significantly more time than other lesson plans of equal depth. Teachers interested in performing a similar unit will need to plan time to:

1) Learn the ins and outs of the GPS units
2) Find appropriate campus locations for the GeoCaching lab
3) Find a feasible site to perform the fieldwork
4) Create a transect line system for the fieldwork
5) Enter the quadrant locations into the GPS units
Lesson Summary

The first day of the project aims to inform students about relevant concepts for the Bear Canyon Arroyo Field Survey Project, these being: location, the United States’ Global Positioning System (GPS), arroyos, and two field survey methods. Students will be introduced to this information through a PowerPoint presentation that requires students to engage with both verbal and visual content. Students will also receive instruction on how to use hand-held GPS units. The “GeoCaching” activity involves having the students find 15-20 pre-determined campus locations using their hand-held GPS units. This will prepare students for using the GPS units to locate survey sites during the fieldwork excursion. The end of the lesson activity involves both class reflection and discussion of the GeoCaching activity, correlating this experience to the future fieldwork. Before the lesson concludes, students will be provided with a packing list explaining the materials they are required to bring for the fieldwork excursion on the next day of class, lesson two.

Curriculum Connection

This lesson integrates geography content into the science classroom, introducing concepts and equipment specific to geography. Students will be made aware of geography’s contributions to science and how the two disciplines can work together. During the PowerPoint, students will learn about absolute and relative location. Further, the GeoCaching activity will allow students to fortify their understanding of these concepts. Students will also learn how GPS receivers have contributed to society’s daily interaction with space and location.

Time Needed (98 Minutes)

- Pre-activity Evaluation – 5 minutes
- Powerpoint Presentation – 30 minutes
- GPS Lesson – 15 minutes
- GeoCaching Activity – 38 minutes
- End of Lesson – 10 minutes
Materials Needed
Computer, PowerPoint Software, PowerPoint Projector, PowerPoint presentation, GPS units, GPS unit instructions, 15-20 campus GPS locations for GeoCaching, GPS Lab Worksheet

Standards
National Geography Standard 1 Grades 9-12: How to use maps and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective. C. Evaluate the applications of geographic tools and supporting technologies to serve particular purposes.
New Mexico Science Standard Strand I: Scientific Thinking and Practice
Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.
9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
Performance Standard I: Describe the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions.

Geospatial Thinking Objectives (Gersmehl, 2008)
Location – Students will understand the importance of absolute location compared to relative location using GPS units to locate specific points on campus.
Condition – Students will describe each absolute location they find.
Hierarchy – Students will become aware that the survey area is part of a larger watershed of central New Mexico.

Starting the Lesson: Pre-activity Evaluation (5 minutes)
The class begins with the bellringer question, “What is a field survey?” The teacher may facilitate this introduction by having students answer this question in writing individually or by having students discuss their thoughts in small groups.
The Lesson (73 minutes)

PowerPoint Presentation (30 minutes)
Teacher will present a Powerpoint slideshow covering: the difference between absolute and relative locations, the United States’ Global Positioning System (GPS), the geomorphology of arroyos, the two field survey methods to be used: transect lines and quadrants, and how to identify grasses, forbs, cacti, and woody plants during the field excursion.

GPS Unit Lesson (5 minutes)
Handheld GPS receivers are not capable of communicating with satellites inside buildings. Thus, the entire class will exit the classroom and proceed outdoors to a setting conducive to effective instruction. The teacher will divide the class into manageably sized groups (ideally 3-4 students) based on available receivers. The teacher will pass out the GPS Receiver Instruction worksheet and explain/demonstrate how to use the GPS units to find a nearby location.

GPS Lab or “GeoCaching Activity” (38 minutes)
The teacher will pass out the GPS Lab Worksheet (See Appendix B, page 41). Students will use their GPS units to locate 6 of 17 possible predetermined locations around campus. Students will use their lab worksheet to mark off the locations they find using their GPS units. Students will record latitude, longitude, and elevation for each location. Additionally, students will answer a riddle at each location, verifying that the group actually arrived at each site. Once all student groups have found their six required locations, students may be given the option to find more locations or to return to the classroom, depending on the amount of time remaining. Throughout this activity, the teacher will rove the area, checking in with participants, answering questions and assessing students’ ability to find locations relying solely on the GPS units.

End of Lesson and Lesson Evaluation (10 minutes)
The teacher will lead a debriefing discussion about the GeoCaching activity with students. Topics to be debriefed include: the precision of the GPS units, the students’
experience of the difference between relative and absolute location, the ability of student
groups to work as a team, and how these elements might impact the fieldwork to follow.
Before closing class, the teacher will collect the GPS Lab worksheets from each group
and later assess each student’s ability to find absolute locations.

References
   Standards Project. Washington DC: National Geographic Research and Exploration
   for the American Geographical Society, Association of American Geographers,
   National Council for Geographic Education, and National Geographic Society.
New Mexico Public Education Department. 2003. New Mexico Science Content
   Standards with Benchmarks and Performance Standards. Retrieved January, 2010,
   from http://www.ped.state.nm.us/standards/.
LESSON TWO: FIELDWORK

Lesson Summary
Prior to this lesson, students will need to return permission waivers from their guardians and teachers to take half of the school day to be in the arroyo. This lesson aims to connect the students with their local/natural surroundings through interdisciplinary fieldwork performed in a nearby arroyo. The fieldwork merges the content areas of science and geography. Students will collect statistical data about the arroyo vegetation by utilizing two common field survey tools: transect lines and quadrants. Students will find their assigned survey sites using the hand-held GPS units to arrive at the center of three assigned quadrants. Once the survey sites have been found, students will mark off the boundaries of each quadrant and collect quantitative and qualitative data about the vegetation and the biological features of each assigned quadrant. Students will also draw a map of the area and sketch a plant and an insect found within each of their quadrants.

Curriculum Connection
Experiential and place-based principles will come to full fruition as students – now in a real-world setting – actively build on skills introduced in lesson one. Students will survey vegetation in a natural arroyo or greenway using methodology similar to that of professional geographers and scientists. The survey combines the use of transect lines and quadrants – two survey tools used in geographic research – with scientific methodology and measurement.

Time Needed (150 Minutes)
Timeframe allows for a second class to return to field site for the second half of the day

- Starting the Lesson/Pre-activity Evaluation – 10 minutes
- The Lesson – 105 minutes
- End of Lesson – 35 minutes
**Materials Needed**
Proper outdoor protection and clothing, extra adult if possible, survey sites with pre-determined absolute locations, GPS units, printouts of GPS unit instructions, printouts of fieldwork instructions for each group, printout of fieldwork data sheets for each student team, metric measuring equipment (metric measuring sticks and/or tap rolls – one stick or roll for each group).

**Standards**

**National Geography Standard 1 Grades 9-12:** How to use maps and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.  
A. Produce and interpret maps and other graphic representations to solve geographic problems.

**National Geography Standard 3 Grades 9-12:** How to analyze the spatial organization of people, places, and environments on Earth’s surface.  
B. Use models of spatial organization to analyze relationships in and between places.

**National Geography Standard 4 Grades 9-12:** The physical and human characteristics of places.  
A. Explain place from a variety of points of view.

**National Geography Standard 8 Grades 9-12:** The characteristics and spatial distribution of ecosystems on Earth’s surface.  
A. Analyze the distribution of ecosystems by interpreting relationships between soil, climate, and plant and animal life.  
B. Evaluate ecosystems in terms of their biodiversity and productivity.

**New Mexico Science Standard Strand I: Scientific Thinking and Practice**  
Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.  
9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.

Performance Standard 1: Describe the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions.
Performance Standard 2: Design and conduct scientific investigations that include:

- testable hypothesis
- methods to collect, analyze, and interpret data
- results that address hypothesis being investigated
- predictions based on results

Performance Standard 3: Use appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculator, balances, and microscopes).

**Geospatial Thinking Objectives:** (Gersmehl, 2008)

**Location** – Students will understand the importance of absolute location compared to relative location using GPS units to locate several specific points within the arroyo.

**Condition** – Students will describe the three survey sites along the transect line, most specifically quantifying the variation among the four identified categories of vegetation.

**Comparison** – Students will collect data from each one of three assigned quadrant locations along a transect line that will eventually be compared with all other quadrants surveyed.

**Transition** – Students will describe the differences between the three quadrants, in particular with reference to the distribution of the four identified categories of vegetation.

**Starting the Lesson: Pre-activity Evaluation (10 minutes)**

Students will meet in their usual classroom location. As in lesson one, the class will open with a bellringer question. The question to open this lesson will be “How close is Bear Canyon Arroyo to its natural state?” Teachers can ask the students to answer this question in writing or to discuss their thoughts in small groups. Either way, the students’ answers to this question will serve as their hypothesis for the field excursion. While students are contemplating their answers or discussing their thoughts with peers, the teacher will take attendance and gather parent permission slips. The teacher will verify submission of required waivers and make a list of students who may or may not attend the field excursion.
The Lesson (105 minutes)

Fieldwork Prep (15 minutes)
Teacher will remind the students of the packing list of required materials and ensure that all students are properly prepared for the field excursion. Students will prepare themselves for the outdoors: putting on sunscreen, adjusting clothing, drinking water, filling-up water containers, using the restroom, obtaining and preparing necessary equipment. While the students prepare to depart, the teacher will rove the classroom, checking for proper clothing and shoes and distributing clipboards and measuring equipment. Students will carry these materials to the arroyo.

Walk to Arroyo (15 minutes)
Before leaving classroom, the teacher will provide some guidelines around walking together to the survey sites. The class will then walk to the survey site without any students passing the teacher/chaperone in the front or falling behind the teacher/chaperone in the back.

Pre-Survey Discussion (15 minutes)
To provide verbal instructions, the teacher will find an appropriate arroyo location, preferably one that allows the class to see the entire survey area. The teacher will now use this outdoor setting as classroom. The teacher will review how to use GPS units. The teacher will handout Bear Canyon Arroyo Survey Instructions (See Appendix B, page 44) and explain the step-by-step processes the students undertake to complete the survey.

Student Survey Location Search (15 minutes)
Building on their experience using the GPS units on campus during Lesson One, students will disband from the Pre-Survey Discussion and use handheld GPS units to find the center of their first quadrant in the arroyo. In searching for the survey locations, students will discover new aspects of the arroyo and strengthen their sense of place within the arroyo and their understanding of local natural communities. Once students have found
their first quadrant, they will be able to choose whether to proceed with their survey of that quadrant or to find their other two survey sites.

**Survey (45 minutes)**

Two field survey methods, transect lines and quadrants, will be used to perform the fieldwork. Each student group will be assigned to one of eleven transect lines to investigate (See Lesson Summaries, page 14). Once each student group finds their survey location, the teams will take a moment to assess the overall landscape and to draw a map of the arroyo with their three survey quadrants. The following steps will be repeated for each of the three quadrants. At the assigned absolute location (the center of one of the three quadrants to be surveyed), student teams will create a quadrant square. Students will use a meter stick to measure a five-by-five meter square and mark off the boundaries of the square. Next, students will separate the vegetation within the quadrant into four broad categories: grasses, forbs, cacti, and woody plants. Students will then count each of these vegetation types separately, breaking the quadrant down into smaller units of measure (decimeters and centimeters) where large numbers of plants dictate doing so. Students will record their findings on the Field Survey Worksheet (See Appendix B, page 46). Students will also record qualitative information by drawing detailed images of a plant leaf and an invertebrate observed within each quadrant. Students will also use their other senses to describe each quadrant. The survey group will then repeat the survey process for the other two absolute locations along their assigned transect line.

**End of Lesson and Lesson Evaluation (35 minutes)**

**Survey Debrief (15 minutes)**

The teacher will find an appropriate arroyo location, preferably one that allows the class to see the entire survey area, and lead a class discussion. The teacher will ask for overall impressions of the assignment/survey and the processes involved and also gather preliminary findings for analysis.
**Return to School Walk** (15 minutes)
Before leaving survey area, the teacher will remind the students of the walking guidelines (how to walk together as a class). The class will then walk back to the school following the same guidelines observed on the earlier walk.

**Student Re-organization** (5 minutes)
Students will be provided time to reorganize their belongings and attire before continuing the day at school. Before the next period bell, each group will submit their Field Survey Worksheet.

**References**


Lesson Summary
The third and final lesson will take place in the classroom. The teacher will return Field Survey Worksheets to survey teams. As a class, survey groups will enter their vegetation data into the interactive whiteboard software. The Promethean software will display the inputted data in bar graphs and students will compare their data with other field groups. Students will analyze the results of the compiled data and compare their initial hypotheses as to how severely the arroyo has been impacted by human activity with their actual observations. The teacher will facilitate a discussion summarizing many of the influencing factors at play in determining the day-to-day condition of the arroyo. The teacher will then conduct a student survey, allowing students to provide feedback on their experience of the project.

Curriculum Connection
This lesson continues to integrate geographic thinking into the biology classroom through class discussions and student analysis of the data collected during the fieldwork excursion. The class survey will assess the effectiveness of the project, lessons students learned, and student opinions of the project.

Time Needed (90 Minutes)
- Starting the Lesson – 10 minutes
- Data Input – 20 minutes
- Student Analysis – 20 minutes
- Teacher Explanations with Student Discussion – 20 minutes
- End of Lesson – 20 minutes

Materials Needed
Interactive whiteboard software and hardware (Promethean was used for this project), completed Field Survey Worksheet by students, and Lesson Three Presentation
Standards

National Geography Standard 1 Grades 9-12: How to use maps and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective. A. Produce and interpret maps and other graphic representations to solve geographic problems.

National Geography Standard 3 Grades 9-12: How to analyze the spatial organization of people, places, and environments on Earth’s surface. A. Apply concepts of spatial interaction (e.g., complementary, intervening, opportunity, distance decay, connections) to account for patterns of movement in space. B. Use models of spatial organization to analyze relationships in and between places. C. Explain how people perceive and use space.

National Geography Standard 4 Grades 9-12: The Physical and human characteristics of places. A. Explain the place from a variety of points of view. B. Describe and interpret physical processes that shape places. C. Explain how social, cultural, and economic processes shape the features of places. D. Evaluate how humans interact with physical environments to form places.

National Geography Standard 7 Grades 9-12: The physical processes that shape the patterns of Earth’s surface. A. Describe how physical processes affect different regions of the United States. B. Explain Earth’s physical processes, patterns, and cycles using concepts of physical geography. C. Explain the various interactions resulting from Earth-Sun relationships.

National Geography Standard 8 Grades 9-12: The characteristics and spatial distribution of ecosystems on Earth’s surface. A. Analyze the distribution of ecosystems by interpreting relationships between soil, climate, and plant and animal life. B. Evaluate ecosystems in terms of their biodiversity and productivity.

National Geography Standard 14 Grades 9-12: How human actions modify the physical environment. A. Evaluate the ways in which technology has expanded the human capability to modify the physical environment.

National Geography Standard 15 Grades 9-12: How physical systems affect human systems.
**National Geography Standard 16 Grades 9-12:** The changes that occur in the meanings, use, distribution, and importance or resources. A. Analyze the relationships between the spatial distribution of settlement and resources. C. Evaluate policy decisions regarding the use of resources in different regions of the world.

**New Mexico Science Standard**

**Strand I: Scientific Thinking and Practice**

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.

Performance Standard 2: Design and conduct scientific investigations that include:
- testable hypothesis
- methods to collect, analyze, and interpret data
- results that address hypothesis being investigated
- predictions based on results

Performance Standard 3: Use appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculators, balances, and microscopes)

Performance Standard 4: Convey results of investigations using scientific concepts, methodologies, and expressions including:
- mathematical expressions and processes (e.g., mean, median, slope, proportionality)
- clear, logical, and concise communication
- reasoned arguments

**New Mexico Science Standard**

**Strand I: Scientific Thinking and Practice**

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

9-12 Benchmark II: Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised or rejected.

Performance Standard 1: Understand how scientific processes produce valid, reliable results, including:
- consistency of explanations with data and observations
- openness to peer review

Performance Standard 2: Use scientific reasoning and valid logic to recognize:
- cause and effect

New Mexico Science Standard Strand II: The Content of Science

Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environment.

9-12 Benchmark I: Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

Performance Standard 1: Know that an ecosystem is complex and may exhibit fluctuations around a steady state or may evolve over time.

Performance Standard 2: Describe how organisms cooperate and compete in ecosystems.

Performance Standard 3: Understand and describe how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients).

Performance Standard 4: Critically analyze how human modify and change ecosystems (e.g., harvesting, pollution. Population growth, technology).

Geospatial Thinking Objectives (Gersmehl, 2008):

**Condition** – Students will describe each campus location they find with the GPS units.

**Connection** – Through data collection and exploration of the field site, students will see how the stream channel connects all the transect lines and as well as the stream channel quadrants.

**Comparison** – Data collected from each quadrant will eventually be compared with the data from the other quadrants along the same transect line as well as all of the quadrants surveyed by other field groups.

**Aura (Influence)** – Students will observe how the survey site is affected by the stream channel, the nearby Sandia Mountains, by the overall climate of the central New Mexico and by numerous other factors.

**Transition** – Students will describe and analyze the characteristics they observe along their assigned transect line. Students will also note and summarize the characteristics they observe for the entire survey area.
Hierarchy – Students will develop an awareness that the survey area is part of a larger area of central New Mexico.

Spatial Model – In class discussion, students will see that impacts originating upstream in the arroyo – outside the survey area – have influenced many of the observed characteristics of the survey sites.

Starting the Lesson: Pre-activity Evaluation (10 minutes)
Students will meet in their normal classroom and be asked once again to revisit the bellringer question posed in lesson two, “How close is Bear Canyon Arroyo to its natural state?” However, this time, the students will have had direct experience of Bear Canyon Arroyo and will have made a number of specific observations as to the state of the field site. The teacher will use this question to set the stage for the facilitation of a class discussion regarding the difference between student hypotheses made prior to the field excursion and actual student findings in the field with regards to the condition of Bear Canyon Arroyo.

The Lesson (60 minutes)
Data Input (20 minutes)
This lesson is primarily focused on allowing the students to analyze the data they collected in the field. First, student groups will review and finalize their quantitative vegetation data. The teacher will then show a Google Earth aerial satellite image of the field sites (See Lesson Summaries, p. 14) and ask student groups to identify their transect lines and quadrants. Interactive white board “clickers” will be distributed so that each student group can input their gathered data. Students will input the total calculated number of each identified category of vegetation (grasses, forbs, cactus, and woody plants) for each of the three quadrants surveyed (A, B, and C). The teacher will guide a discussion aimed at helping students identify possible flaws in the data or obvious variations in numbers between field groups.
**Student Analysis (20 minutes)**

After data has been entered, students will verbally compare the characteristics of their quadrants (A, B, and C) to those of other field groups. Students will verbally summarize their findings for the rest of the class. Students will then explain – within the context of the arroyo as a whole and any large-scale observations made – why each of their quadrants possessed the particular characteristics that were observed. The teacher can guide these presentations with appropriate questioning to help elucidate the distinct differences between stream channel quadrants (quadrants A) and flood plain quadrants (quadrants B and C). Students will also be asked to critically analyze survey findings in relation to their understanding of the natural distribution of vegetation in undisturbed arroyos. Synthesizing their observations with their understanding, students will be asked to explain what influencing factors may have altered the distribution of vegetation at the field site.

**Teacher Explanations with Student Discussion (20 minutes)**

The teacher will follow student explanations with a presentation of actual events and factors that impacted the arroyo. The teacher will spend roughly 5 minutes discussing each one of four selected impacts identified in the history of the arroyo. The teacher will also facilitate a discussion of how natural and human influences on the arroyo are reflective of the interaction between human impacts and environmental conditions.

**End of Lesson and Lesson Evaluation (20 minutes)**

The teacher will evaluate the overall impact of the project by conducting a student survey using interactive whiteboard technology. Students will express their impressions of the project, their experience, and what they learned by responding to a number of multiple choice and short-answer questions. The teacher will look at the compiled responses to assess the success of the project and whether or not the educational objectives of the project were met.
References

Standards Project. Washington DC: National Geographic Research and Exploration
for the American Geographical Society, Association of American Geographers,
National Council for Geographic Education, and National Geographic Society.
New Mexico Public Education Department. 2003. New Mexico Science Content
Standards with Benchmarks and Performance Standards. Retrieved January, 2010,
from http://www.ped.state.nm.us/standards/.
APPENDIX B

TEACHER MATERIALS AND STUDENT WORK SAMPLE
Mark the locations on the map below.
Location #1
Relative Location on Campus:
Latitude:
Longitude:
Elevation:
Why is this a good place for a meal?

Location #2
Relative Location on Campus:
Latitude:
Longitude:
Elevation:
What is the importance of this area?

Location #5
Relative Location on Campus:
Latitude:
Longitude:
Elevation:
How many trees stand here?

Location #8
Relative Location on Campus:
Latitude:
Longitude:
Elevation:
What shape is this large concrete structure?

Location #11:
Relative Location on Campus:
Latitude:
Longitude:
Elevation:
How many stars are on this wall?

Location #16
Relative Location on Campus:
Latitude:
Longitude:
Elevation:
From this vantage, I would be able to see what kind of game?
FIELDWORK INSTRUCTIONS

Bear Canyon Arroyo Survey Instructions

Step 1: Find Locations  Use GPS units to find one or all three of your locations, recording latitude, longitude and elevation for each site.

Step 2: Draw General Map  Map must include legend, directional compass, boundaries of arroyo, the channel of the stream, and your team’s three sites.

Step 3: Quadrant  Using your newfound skills of metric measurement, lay out a square plot or quadrant that is five meters by 5 meters. You will want to mark the four points of your square with objects that are easy to keep track of (bandanas, large stick or rocks). The quadrant doesn’t have to be perfect.
FIELDWORK INSTRUCTIONS (CONTINUED)

Step 4: Collect Quantitative Data
Once the quadrat has been laid out, you will now systematically itemize four different types of plants within your area: 1) Grasses/Yucca 2) Forbs 3) Cacti 4) Small Trees/Woody Shrubs. The number one priority of the group is to get a total count for each category of plant for each area. Due to the time constraints, it will be necessary to divide the work amongst your team members. A plot of five square meters is fairly large, so it will be a good idea to divide it into quarters and assign members to each part. As a team, you must compile all of your data. Each team member must have their own full copy of the data totals.

Grasses & Yucca
These plants are closely related. Both grow in bunches, but yucca are typified by stiff leaves that have sharp points, while leaves of grasses are flexible and without points.

Forbs
Forbs are small to minute bushes that do not have tough, bumpy stems, but rather light or tender green stems. These are likely to be quite numerous.

Cacti
The two predominante cacti in the foothills are cholla and prickly pear. In addition to these, you may find hedgehog and pincushion varieties.

Small Trees & Woody Shrubs
These are the larger plants in the desert arroyo habitat. Native trees can reach up to 4 meters while most shrubs are around 1 meter tall. Woody shrubs have stems with a dry bark like appearance.

*Advanced Gathering Techniques – For those groups who would like to give themselves a challenge, there are many ways to make your data more specific. One way involves breaking each group into specific species and accumulating itemizations for each within the broader type of plant. Additionally, data can be further refined by creating subgroups based on size/maturity of the types of plants. A team might also note proportions of particular plants that are in a state of flowering. Bonus points may be earned for these extensions.

Step 5: Collect Quantitative Data

**Leaf of Predominate Plant**

Draw within the circle the individual leaf of the predominante plant in the site. Pay close attention to the details like leaf shape, margin, and vein structure. Include other noteworthy descriptions (plant size, flowers, fruit, growth pattern, etc.)

**Invertebrate**

Draw within the circle an invertebrate (insect, spider, worm, etc.). You should attempt to capture their anatomy in as vivid detail as possible. Include descriptions of colors, sounds, movement, and behavior in the additional section of “Other Notes.”

* In the “Other Notes” section also include the descriptions of your other senses (hearing, smell, and touch.)
STUDENT FIELD SURVEY WORKSHEET

Bear Canyon Arroyo Survey

Surveyers:
_________________________  _______________________

Bear Canyon Arroyo Map

North Site
Latitude:
Longitude:
Elevation:

Qualitative Data  Quantitative Data

Leaf of Predominate Plant  Invertebrate

= = =

Other Notes: ____________________________

= = =
STUDENT FIELD SURVEY WORK SAMPLE

Bear Canyon Arroyo Survey

Surveyors:

Bear Canyon Arroyo Map

Stream Channel

Latitude: N 35° 08' 14.8"
Longitude: W 106° 30' 42.8"
Elevation: 1750

Quantitative Data

Leaf of Predominant Plant

Invertebrate

Other Notes: 

= 45,900 forbs

= 3 prickly pear cacti

= 17 woody shrubs
Graph of Student Survey Results

Average Scores for 62 Student Opinions on Survey Objectives

- Strongly Agree: 1.16
- Agree: 2.05
- Indifferent: 1.89
- Disagree: 2.78
- Strongly Disagree: 3.38

- Enjoyed Going Outside Classroom: 1.55
- Enjoyed Lesson of Survey: 2.73
- Using GPS to find transect lines was Fun: 2.73
- GPS Helped Teach Latitude & Longitude: 2.73
- Setting Up Plots & Counting Plants was Fun: 2.73
- Setting Up Plots Helped me Understand Scientific Measurement: 3.38
- My Team Functioned as a Team: 3.38
REFERENCES


Grosvenor Center for Geographic Education and National Geographic Society Education Foundation. (n.d.). Why geography is important: understanding the world, cultural diversity, environment and society, globalization [Brochure].


