# Making Geology Relevant to Non-Science Majors Through the Environmental Site Assessment Project

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## ABSTRACT

The Environmental Site Assessment (ESA) project was developed to make geology more relevant to the non-science majors in Appalachian State University's Environmental and Applied Geology course. Pedagogically, this exercise is an example of directed-inquiry. Students are guided in applying the geoscience theory learned in the formal classroom setting to the reality of their own independent research projects. Through participation in the ESA project, students investigate earth resource issues of water quality and water supply, and geologic hazards specific to each student's place of residence. Student survey results indicated that this project had a positive impact on students' perceptions of the value and relevance of geoscience, particularly that knowledge gained from the ESA project would be very helpful to them in future decision-making situations, such as home or business site selection. With little modification, this exercise is transferable to survey geology courses at other colleges and to middle and high school earth and environmental science programs.

Keywords: Engineering and Environmental Geology, Education – Geoscience, Education - Undergraduate

## INTRODUCTION

The introductory level Environmental and Applied Geology course (GLY 1103) taught at Appalachian State University has as course goals that: (1) students gain an understanding of the geologic processes and products that impact humans, including natural hazards and natural resources, and (2) students use this knowledge in finding solutions to geologically-related practical problems facing modern society. In addition, we recognize the need to convey the personal relevance of Earth Science to the non-science major. Most of the students taking this survey class (enrollment: 20-80 students per section) are largely business, humanities, or fine and applied art majors seeking to meet their core curriculum science requirements. It is our perception that while many of these students bring a natural curiosity about geology to the class, there is a significant subset that either generally dislike science or are science-phobic – many of whom postpone taking their core curriculum science classes until their junior or senior year. We hypothesize that this situation is due to their minimal personal experience in this discipline.

To meet the educational goals of the course and our desire to make earth science more relevant to the non-science majors, we developed an inquiry-based exercise entitled The Environmental Site Assessment (ESA) Project as described below. Our ESA project shares some similarities with the Geologic Hazard Assessment proposed by Stull (2000), although these assignments were created independently. The ESA project has been met with measurable success and student enthusiasm as an additional course activity. We propose that student involvement in this directed, but independent project makes geology personal and relevant to the non-science major. Learners not only gain specific knowledge about local environmental and geologic issues, but also gain a better appreciation for the importance of geology in society.

## LEARNING THROUGH DIRECTED-INQUIRY

Pedagogically, the ESA project is a directed-inquiry exercise. The directed-inquiry approach in science teaching is based on the principle that students are capable of learning though inquiry if background information is sufficiently developed and students are given enough guidance in the process of inquiry so that they can advance to independent work (Germann, 1989; National Academy of Sciences 2000). Germann (1989) demonstrated that a directed-inquiry approach to learning science aided the development of learners' reasoning abilities. This is significant because Lawson (1985) has shown that there is a correlation between deficiencies in reasoning ability and poor achievement in science. Directed-inquiry, therefore, may help counter the problem of poor achievement in science.

The ESA project fits within the directed-inquiry model in that, after students possess the concepts required to understand geologic hazards and earth resources through their participation in lecture and lab, students are required to apply theory to reality, and independently assess the water resource issues and geologic hazards of their home site. They are guided in what to ask by the directions laid out in the assignment and by the sample checklists we refer them to (Tables 1-3). However, unlike some other directed inquiry projects for non-science majors (e.g., Oyler et al., 1999), students are, by design, given minimal guidance as to how and where to collect data for their ESA projects. We proceed in this way because inquiry for the ESA project primarily depends on a student's curiosity and basic skills of investigation, and not on specific scientific procedures (e.g., lab methods) that would perhaps be unfamiliar to a non-science major. Not giving students a cookbook procedure for how and where to collect data gives each student the freedom to select a location they are curious about as their project focus, and to think about the best way to obtain information about that site. The bottom line is that how and where the students seek out data depends on the specific site each student selects for his/her personal project and on the student's level of motivation.

## THE ESA PROJECT

The ESA project assignment is presented to the students on the first day of class as part of a detailed syllabus. We preface the assignment by stating that there are a number

**Write a 3-4 page (typed, double-spaced) report, with appendix for map(s) and other images, that includes:**

1. A description of the source of your home (or dorm) drinking water supply and methods of treatment,
2. A descrption of the fate and treatment of your residential waste water,
3. A description of the management of your residential solid waste and problems associated with its disposal,
4. A geologic hazard/environmental site assessment of your residence, and
5. A topographic map and a sketch or photos of your residence.

**Table 1. Student requirements for ESA project.**

of geology-related issues that particularly affect property owners and potential home or business buyers. By understanding geologic principles and processes an individual will make better-informed and responsible home or business buying and owning decisions. In this light the Environmental Site Assessment project is assigned (Table 1). The primary goal of Parts 1-3 of the ESA project is to have students make the link that their resource use (e.g., water) directly impacts and relies upon the surrounding environment. The primary goals of Parts 4 and 5 are: (a) to apply their knowledge about geologic hazards in assessing the level of risk for such hazards at their chosen site, (b) to become familiar with the local geology, and (c) to integrate the use of maps in making a site assessment. Classroom introduction to geologic hazards (e.g., landslides, flooding) and resource issues (e.g., water supply and quality, soils) provide the content background required to proceed with this activity.

Parts 1-3 require little guidance by the instructor. It is our experience that most students simply need to be pointed in the right direction and the investigator in them takes over. For example, learning about the source and treatment of drinking water for a student's dorm may start by simply calling personnel at the university physical plant. We usually make such a suggestion in class when the assignment is introduced. The students then continue to inquire as they see fit given their site of focus for this project.

More direction is given to students for Parts 4 and 5 of the ESA project because these portions rely more heavily on a student's own scientific observations, than do Parts 1-3. To guide students in their geologic hazard/environmental site assessments (Part 4 of ESA project) we direct them to one of four sources for a list of sample geologic hazard criteria a homebuyer should be on the alert for when performing a site assessment (Tables 2 and 3). We then tell each student to walk around his/her site and make observations based on the sample criteria provided and the background presented in lecture and lab regarding different types of geologic hazards. Given the geologic setting in which many of our students live (the Blue Ridge Mountains), we generally expect that they address the potential for different forms of mass wasting, flooding, and radon risk. In other cases, coastal erosion, subsidence, and earthquake risk may be of prime importance to consider. In addition, we

- *Homebuyer's Guide to Geologic Hazards* (AIPG, 1996)
- *The Citizens' Guide to Geologic Hazards* (AIPG, 1993, p. 127)
- The West Virginia Geology and Econoimic Survey website (www.wvgs.wvnet.edu)
- An Environmental Site Assessment check sheet may be obtained from a local consulting firm

**Table 2. Sources to use for Part 4 of the ESA project.**

- What is the flood risk?
- Is there evidence of soil creep which might affect site stability?
- Is the property vulnerable to landslides, rockfalls, or avalanches either above or below the site?
- What is the potential for destructive earthquakes occurring on or near this site? Are there any active faults?
- Do your local laws require the realtor, builder, or developer to disclose presence of geological hazards?
- What are the levels of radon in your house? If high, can mitigation measures be taken?

**Table 3. Sample criteria for Part 4 of ESA project (modified from AIPG, 1996).**

recommend that students consult geologic maps (e.g., to determine if there are any local faults), contact a real estate agent (e.g., to determine if a professional geologic site assessment is required before a real estate transaction), and consult state and federal agency websites (e.g., USGS, EPA) for further information on geologic hazards.

Because the home site assessment should involve examination of the topography (e.g., for mass wasting risk) and proximity to bodies of water (e.g., for flooding risk), inclusion of a topographic map and a sketch or photos of their site is important (Part 5 of ESA project). Inclusion of these artifacts ensures thoroughness on their part and provides the instructor with another means to evaluate reports for accuracy. If, for example, the topographic map included in a report is marked with the student's home site on the banks of a river, yet there is no mention in the written part of the report of the potential for flooding, it is unfortunately clear that the student failed to make a good home site assessment. Topographic maps can be obtained from two on-line sources: www.terraserver.com or www.topozone.com. The benefits of using one of these sources are that: (a) it is free to download a topographic map, (b) the map can be modified electronically to add text identifying their home site, and (c) it introduces them to a valuable resource that they can access from anywhere.

The ESA project report is the culmination of the learner's investigation and should reflect a synthesis of the data collection and interpretation. The report is best due late in the term, after students have attended lectures and labs relevant to the assignment. The ESA project grade is based on: (a) how thoroughly they investigated Parts 1-4 and that Part 5 was completed, (b) the accuracy of their explanation and assessment, and (c) the clarity of

- "I'll always remember the basics of this project and implement my skills even when assessing a new rental house...now I know how to ask the right questions for home ownership or new construction sites."
- "I found it to be very helpful because it forced me to think about different factors and put them together, hands-on, which in turn helped me understand them beter."
- "I think the ESA project was probably the most practical application of concepts we learned in class and showed me that it was easy to learn about where my resources come from. Also it was a good learning experience in dealing with people who work in the water and waste treatent industry."
- "It gave me an understading of how geology is used in everyday life."

**Table 4. Sample anonymous written comments from students' surveys.**

| **Question: Knowledge gained from which of the following do you expect to be most helpful to you in the future (e.g., selecting a site for a house, assessing geologic risk, evaluating environmental issues in the news, voting on environmental issues)? (Rank your selection)** | | | |
|---|---|---|---|
| Responses: ESA Group | Rank | | |
| | 1st | 2nd | 3ed |
| Lecture material | 38 | 6 | 3 |
| Text readings (a) | 8 | 3 | 3 |
| Outside readings (b) | 4 | 5 | 3 |
| Your ESA project | 24 | 7 | 6 |
| Lab material (c) | 6 | 7 | 7 |
| Your extra credit project (d) | 2 | 0 | 0 |
| None of the above | 1 | 0 | 0 |
| Other | 0 | 0 | 0 |
| Responses: Non-ESA Group | Rank | | |
| | 1st | 2nd | 3ed |
| Lecture material | 59 | 3 | 0 |
| Text readings (a) | 13 | 5 | 4 |
| Outside readings (b) | 6 | 2 | 3 |
| Your ESA project | N/A | | |
| Lab material (c) | 13 | 6 | 3 |
| Your extra credit project (d) | N/A | | |
| None of the above | 4 | 0 | 0 |
| Other | 2 | 2 | 1 |
| **Question: Ten years from now which of the following do you think you will still remember something about (rank your selections).** | | | |
| Responses: ESA Group | Rank | | |
| | 1st | 2nd | 3ed |
| Lecture material | 27 | 7 | 2 |
| Text readings (a) | 3 | 3 | 1 |
| Outside readings (b) | 1 | 3 | 2 |
| Your ESA Project | 23 | 7 | 7 |
| Lab material (c) | 7 | 7 | 2 |
| Your extra credit project (d) | 2 | 0 | 1 |
| None of the above | 2 | 0 | 0 |
| Other | 1 | 0 | 0 |
| Responses: Non-ESA Group | Rank | | |
| | 1st | 2nd | 3ed |
| Lecture material | 52 | 1 | 0 |
| Text readings (a) | 7 | 2 | 4 |
| Outside readings (b) | 3 | 1 | 0 |
| Your ESA project | N/A | | |
| Lab material (c) | 10 | 9 | 1 |
| Your extra credit project | N/A | | |
| None of the above | 9 | 0 | 0 |
| Other | 2 | 0 | 0 |

| Question: What do you think was the most valuable learning experience in this course? (Rank your selections) | | | |
|---|---|---|---|
| Responses: ESA Group | Rank | | |
| | 1st | 2nd | 3ed |
| Listening and taking notes in lecture | 31 | 4 | 6 |
| Reviewing material (class web site & library) | 4 | 5 | 2 |
| Working on your ESA project | 20 | 9 | 2 |
| Completing lab exercises | 9 | 7 | 4 |
| Working on your extra credit project | 1 | 0 | 2 |
| Other | 1 | 0 | 0 |
| Responses: Non-ESA Group | Rank | | |
| | 1st | 2nd | 3ed |
| Listening and taking notes in lecture | 45 | 2 | 3 |
| Reviewing material (class web site & library) | 11 | 4 | 1 |
| Working on your ESA project | N/A | | |
| Completing lab exercises | 11 | 6 | 5 |
| Working on your extra credit project | N/A | | |
| Other | 6 | 1 | 0 |

**Table 5. Student survey results. (a) The textbook used was Environmental Geology by Keller (2000). Other than reading their textbook daily homework was not assigned. (b) Outside readings were only assigned in sections taught by St. John. Outside readings were primarily from The Earth Around Us edited by Schneiderman (2000). (c) Lab sections were not necessarily taught by the lecture professor. (D) Optional extra credit projects were only only assigned in sections taught by St. John. The extra credit project was a creative endeavor that related the student's major to some aspect of material covered in this course.**

their writing. For Part 4 in particular, we expect justification for why a student's home site is or isn't at risk for the various geologic hazards and what could be done to minimize the risk. The assignment typically accounts for between 5% and 15% of the final grade.

## EVALUATING STUDENT LEARNING

Over the six years that the ESA project has been requirement in our courses, anecdotal evidence has accumulated in the form of written comments by students on course evaluation forms and in student ESA reports indicating that this project improved students' perception of science. To better assess these issues and to assess our teaching approaches in general, we developed an end-of-semester student survey that included six questions ranking different aspects of the course (three directly related to the ESA project) and one question asking for written comments. Fifty-five students that participated in the ESA project were surveyed, and 75 students that were not assigned the ESA project were also surveyed to provide a baseline for comparison. Written comments regarding the value of the ESA project in meeting the stated course goals and their goals for the course were largely positive (Table 4). Overall, 36 students had positive written comments and 3 students had negative written comments. The negative comments made were related to the issue of course workload.

Results from the surveys show that the students uniformly ranked lecture participation, followed by ESA project participation, as the "most helpful", the "most valuable", and the "most memorable" aspect of the course (Table 5). These results suggest the ESA project had a positive impact on students' perceptions of the value and relevance of geoscience. In addition, given the current pedagogical paradigm of active or inquiry-based learning, it was interesting that the surveyed students valued the more standard pedagogy of traditional lecture so highly. We suggest three re asons for this. First, lecture material is often of a practical nature. This is inherent to the field of environmental geology. For example a lecture on mass wasting not only describes what mass wasting is, but also what the warning signs and preconditions are of a landslide. (A relevant and practical topic for a school in our geographic setting.) Second, efforts are made in lecture to draw on local, regional, and recent examples of geologic hazard and resource issues, presumably making the material presented relevant (and therefore valuable or memorable) to the students. And third, because students take tests on the material presented in lecture, students recognize the value of participating in lecture, albeit often passively.

A comparison of mean final course grades of the ESA group with the non-ESA group was also made for those students that shared the same lecture professor. This is reported as standard GPA, where A = 4.0, B = 3.0, C = 2.0, etc. The mean GPA of the ESA group was 2.69, whereas it was 2.17 for the non-ESA group. Assuming higher grades indicate greater conceptual understanding of the content, these results suggest the ESA project enhanced student learning.

## CONCLUSIONS

The student survey responses suggest that the ESA project is an effective means of making geology more relevant to non-science majors, and the GPA comparison suggests that participation in the ESA project enhances student learning. The approach of directed-inquiry provides a pedagogical framework in which students explore the practical nature of geology, guided by an initial set of instructor-posed learning goals and the student's own curiosity about their interactions with the earth and its environment.

With little modification, this exercise is transferable to survey geology courses at other colleges and to middle and high school earth and environmental science programs. In adapting this exercise, we suggest that educators focus on geologic hazard and resource issues pertinent to their local or regional community. In addition, middle and high school educators may want to add some additional pre-activities, such as field trips to water treatment facilities and waste disposal centers, and a group environmental site assessment of the school grounds prior to students' independent home site assessments.

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