GEOL 106: Environmental Geology—A Peer Review of Teaching Project Benchmark Portfolio

Leilani Arthurs
University of Nebraska-Lincoln, larthurs2@unl.edu

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Peer Review of Teaching Program 2012-2013

Benchmark Portfolio

for

GEOL 106: Environmental Geology
Spring 2013

prepared by

Leilani Arthurs

submitted on

Friday, May 31st, 2013
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INTRODUCTION

Introduction to the Peer Review of Teaching (PRT) Benchmark Portfolio

The Peer Review of Teaching (PRT) program provides faculty members the environment, support, structure, and time to carefully think about how they teach a particular course. PRT benchmark portfolios are prepared as a part of this program to assist faculty members in reflecting on and documenting their instructional practices and the potential impact they have on student learning.

This benchmark portfolio targets the Spring 2013 semester of GEOL 106: Environmental Geology. It documents the course objectives that provided the foundation for the instructional approach, the course-level learning goals that defined what students should be able to do by the end of the course, a description of the approach to teaching intended to facilitate students attainment of the learning goals, examples of the instructional strategies and assessments used in the course, and the student learning outcomes (i.e. what students actually can do with respect to the learning goals at the semester’s end).

Target Course & Semester

GEOL 106: Environmental Geology
Spring 2013

Author & Contact Information

Leilani Arthurs
Assistant Professor
330 Bessey Hall
P.O. Box 880340
Department of Earth and Atmospheric Sciences
larthurs2@unl.edu; 402-472-6353
University of Nebraska-Lincoln
A. GOALS OF PEER REVIEW COURSE PORTFOLIO

A.1. Key Goals

The key goals I wanted to accomplish in creating this benchmark portfolio dealt with teaching on the one hand and learning on the other. With respect to teaching, I used the portfolio as a means to document the course objectives, learning goals, instructional strategies, and student learning outcomes the Spring 2013 semester of GEOL 106: Environmental Geology. In addition, I used it to identify areas that I would like improve and further develop. With respect to learning in Spring 2013, I used this course portfolio to address and document to the extent possible how (i) students were engaged, (ii) student interest in science was impacted, (iii) students’ geoscience content knowledge was broadened, (iv) students’ became more expert in terms of their attitudes towards science and learning science, and (v) students further developed basic academic/professional skills.

A.2. Primary Objective

The primary objective of this benchmark portfolio is to provide a broad overview of the entire course as it was taught during Spring 2013. Nevertheless, there is greater focus on the in-class activities, formative assessments, and summative assessments because these are areas that can be further developed and refined. To my knowledge, my portfolio is not part of a larger departmental effort in curriculum development and analysis; however, I would be amenable to it being part of such an effort.

A.3. Benefits

Preparing this benchmark portfolio was beneficial in several ways. It primarily served as an opportunity to reflect on my approach to facilitating students learning and to explore what students may (or may not) be gaining from their experience in the course. In this sense, preparation of this portfolio also involved capturing some elements of the baseline conditions of this course, which aided me in identifying areas of the course that I can improve. In addition, this portfolio has the potential to serve as the basis for a publication in the scholarship of teaching and learning. Finally, this portfolio also has the potential to be valuable to those reviewing my professional development and performance in my home Department and at UNL.
B. DESCRIPTION OF THE COURSE

B.1. Content

My target course for the Peer Review of Teaching (PRT) benchmark portfolio is an introductory-level course titled GEOL 106: Environmental Geology (see Appendix A: Syllabus). It is a large enrollment and ACE 4 certified lecture course that currently has no affiliated lab section or lab course. GEOL 106 is about environmental geology and examines the nexus between the environment and humans. It adopts the perspective that planet Earth is an Earth system. This Earth system is composed of the interconnected geosphere, hydrosphere, atmosphere, and biosphere. Within this system, humans are an important agent that is both impacted by and benefits from the system’s conditions while simultaneously also actively transforming the very system in which it resides. I designed the course to cover four key content areas. (i) What is science and how do scientists know what they know? (ii) How do Earth processes, particularly natural disasters, impact people? (iii) How does the Earth, particularly its natural resources, allow people to live the way we do? (iv) How do people cause environmental impacts?

B.2. Target Audience

The course is designed primarily for lower-division non-STEM (science, technology, engineering, and mathematics) majors seeking to satisfy their general education ACE 4 requirement. Nevertheless, the course does attract upper-division students and students from STEM majors. In the past, the course attracted ~120 students; however, in the past two years, numbers declined. In the Spring 2013 semester, the course had an initial enrollment of 58 students. Fifty-five of these 58 completed a beginning of the semester questionnaire. Of these 55, there were 20 freshmen, 17 sophomores, 10 juniors, and 8 seniors. Furthermore, 69% were Nebraska residents, 24% were out of state students, and 11% were international students.

B.3 Course Objectives & Student Learning Goals

Three broad course objectives provide the overall framework for the direction, flow, and tone of this course. The first is to provide freshmen and sophomores the opportunity to grow and develop habits of mind that will aid them in their journey of life-long learning and their role as scientifically savvy citizens. The second is to discuss the interaction between Earth processes and humans’ current ways of living through inspection of environmental issues including natural disasters, natural resources, and environmental impacts. The third is to develop a community of learners where our interactions make learning science both accessible and even enjoyable.

Within this framework, students in the course learn (i) about Earth processes over which humans have little or no control, (ii) how human life and the built environment are dependent on the natural environment, and (iii) about the impact that human actions have on the Earth system. The course stresses scientific methods used to evaluate problems of local, regional, and global concern as a way to highlight how scientists study the Earth system and how they know what
they know about it. This engagement is grounded in the theory of constructivism as well as in efforts to foster peer-to-peer and learner-to-instructor communication and to cultivate a safe environment so that a community of learners can thrive.

Seven key student learning goals compliment the course objectives. Upon successful completion of this course, students should be able to: (i) exercise successful learning strategies, including communication skills, collaborative skills, and note-taking skills (which involves careful listening, identifying what’s important, and recording it for future reference); (ii) distinguish “good science” from “bogus science;” (iii) know the meaning of important terms relevant to environmental geology; (iv) explain critical geologic concepts and first principles; (v) apply critical concepts and first principles to analyze geologic data and case studies; (vi) describe methods used by geologists and other scientists to study the Earth system, and last but not least; (vii) approach science and the learning of science in a more informed and confident way.

The course objectives and student learning goals (Table 1) form the foundation of this course’s structure and the expectations that I share with students about their role and my role in the course as well as the approach we will use in teaching and learning during the semester. Not only do they inform my expectations, they also guide my approach to teaching the course. This includes decisions about what instructional strategies to use, how and when to assess student learning, and how to provide and use feedback on student performance to enhance their learning experience. From the student perspective, the outlined course objectives and student learning goals provide them direction, focus, and a target for which to aim. These objectives and goals are appropriate for the students because they are fundamental to student learning and success; students who achieve these goals will be better prepared to succeed in other courses (whether in the major or not), will be more independent and self-motivated learners, and will contribute to their families and communities as scientifically savvy citizens whether they become scientists or not.

<table>
<thead>
<tr>
<th>Student Learning Goals</th>
<th>Course Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Student will be able to successfully use learning strategies such collaborative skills, communication skills, reading comprehension skills, and note-taking skills.</td>
</tr>
<tr>
<td>#2</td>
<td>Student will be able to distinguish between “good science” and “bogus science.”</td>
</tr>
<tr>
<td>#3</td>
<td>Students will be able to describe the meaning of important terms relevant to environmental geology.</td>
</tr>
<tr>
<td>#4</td>
<td>Students will be able to explain critical geologic concepts and first principles relevant to environmental geology.</td>
</tr>
<tr>
<td>#5</td>
<td>Students will be able to apply critical concepts and first principles to analyze data and case studies.</td>
</tr>
<tr>
<td>#6</td>
<td>Students will be able to describe the methods used by geologists and other scientists to study the Earth system.</td>
</tr>
<tr>
<td>#7</td>
<td>The primary objective of this course is to provide students with the opportunity to grow and develop habits of mind and attitudes that will aid in their journey of life-long learning and role as scientifically savvy citizens.</td>
</tr>
<tr>
<td>#8</td>
<td>The secondary objective of this course is to discuss the interaction between Earth processes and humans’ current ways of living through inspection of environmental issues including natural disasters, natural resources, and environmental impacts.</td>
</tr>
</tbody>
</table>

Table 1. Summary of student learning goals and course objectives.
C. APPROACH TO TEACHING & LEARNING

C.1. Teaching Methods: In Class

The overall approach to teaching this course is the *interactive lecture*. This approach falls in the middle ground between a traditional approach to teaching (i.e., purely centered on lecture) and the kind of transformed approach to teaching that is entirely void of lecture and based purely on individual student and/or group work. My rationale for choosing this particular approach is based on reasons I have for neither ascribing to a traditional lecture approach nor ascribing to an approach based purely on student group work. My reasons for the former include: (i) a substantial body of research from the fields of educational psychology, learning sciences, and STEM education that indicates lecture alone is ineffective at achieving deep learning; (ii) this body of research also indicates student engagement is central to achieving deep learning; (iii) students can easily access information found in traditional lectures on the internet and my goal is to have value added for students in the class; (iv) interacting with and learning from my students helps me to better understand their viewpoints, understandings, and experiences so that I can shape the direction of the course in a way that meets their needs – this would not be possible if I spent our time together in class talking *at* them instead of *with* them; and last but not least (v) I find it personally more challenging and fulfilling to have an interactive lecture with two- or multi-way interactions than to only lecture from one class meeting to the next. My main reason for the latter is that there does not exist sufficient time in a single average semester to make the sizeable time investment required to develop in-class activities that could constructively be used to fully replace lectures and the out-of-class activities needed to support them. and (ii) research indicates that fully transformed courses in institutions with a dominant culture of traditional instruction are often met with resistance that adversely impact student evaluations of teaching that are used to inform merit raises, promotion, and tenure.

This interactive lecture approach utilizes a variety of strategies intended to engage students in their own learning process; the foundation of the course is lecture and within each lecture are embedded in-class activities. The lectures are intended to bring students’ focus to key ideas, concepts, and themes that are central to the course and/or for which identified learning difficulties are associated. In addition, making the lecture slides unavailable online or otherwise is intended to facilitate students’ development of an important professional skill, note-taking, which involves listening comprehension, identification of the important ideas, and recording information in such a way that it is a useful study aid and future reference. Although this practice of not posting lectures runs counter to many other courses, I do believe that I would be robbing students the opportunity to develop an important life skill, note-taking skills, by posting the lecture notes. I explain this practice and the rationale to my students during the first week the semester and then periodically after that.

In-class activities are intended to explicitly engage students in focused thinking, exploration, and application of key ideas, concepts, and themes. In-class activities are intended to facilitate student attainment of learning goals by providing the opportunities to (i) reveal students’ prior conceptions, challenge them if needed, resolve possible cognitive dissonance, and scaffold between prior and new knowledge; (ii) practice and reinforce learned concepts and principles,
(iii) learn how to solve a specific type of problem; (vi) apply critical concepts and first principles to analyze a particular scenario; (vii) facilitate the development of other important professional skills, including communication and collaboration with others; and last but not least (viii) give students a voice in the course and a sense of ownership over their learning.

In-class activities are used throughout the semester and in every class meeting. They involve various combinations of individual, paired, and group work. They are undertaken prior to, during, or after explicitly addressing an idea, concept, or theme via lecture. These activities are aligned with well researched evidence-based pedagogies and promising practices that lead to higher learning gains in undergraduate STEM courses as compared to lecture alone. They include but are not limited to the following (please note that I’ve included links to additional information about each strategy for readers who would like to learn more about them):

1. Classroom assessment techniques
2. Interactive lecture demonstrations
   http://serc.carleton.edu/introgeo/demonstrations/index.html
3. Collaborative learning
   http://serc.carleton.edu/introgeo/icbl/prepare.html
4. practice questions / ConcepTests
   http://serc.carleton.edu/introgeo/interactive/conctest.html
5. Think-pair-share / Peer Instruction
   http://serc.carleton.edu/introgeo/interactive/tpshare.html
6. Lecture tutorials
   http://serc.carleton.edu/NAGTWorkshops/teaching_methods/lecture_tutorials/index.html
7. Problem-based worksheets
   http://serc.carleton.edu/introgeo/cooperative/examples/uvmenace.html
8. Case studies / case-based worksheets
   http://serc.carleton.edu/sp/library/cases/index.html
9. Just-in-Time-Teaching
   http://serc.carleton.edu/introgeo/justintime/what.html

The rationale for implementing a number of strategies instead of the same strategy every day is three-fold. First, lesson-level learning goals guide the choice of the strategy best suited to facilitating student attainment of those goals. In other words, the strategy must be aligned with the targeted learning goal. Second, implementing a variety of activities is intended to keep students interested in learning by bringing a sense of the expected unexpected. In other words, they know the course is based on interactive lecture but they don’t know exactly what each day will bring and what they will be asked to discuss or do. Third, I expect that student engagement in these ways will result in the desired student learning outcomes.

An example of an in-class activity used prior to explicit lecture on a given topic involves students answering an open-ended question about it, my aggregating their responses after that class, and then my using their aggregated responses as a springboard for discussion and further investigation in the next class meeting (see Appendix B: Open-ended Q converted to multiple-
choice Q: Petroleum Extraction); this is then followed by some lecture. Examples of in-class activities that are used during explicit lecture on a given topic are whole class guided discussions, practice questions using colored cards, lecture tutorials, and interactive lecture demonstrations (see Appendix C: Whole-class Guided Discussion: Plate Tectonics, Appendix D: Lecture Tutorial: Floods and Flood Probability, and Appendix E: Interactive Lecture Demonstration: Porosity and Permeability). An example of an in-class activity after explicitly discussing a topic in class is a case study (see Appendix F: Case Studies: Climate Change).

These in-class activities serve as formative assessments that provide insights into student thinking and learning. Most in-class activities are collected and analyzed after the class meeting in which they are collected, findings of the analysis are then integrated into the next class meeting. In-class activities that students are asked to keep as a future study guide are extensively discussed and debriefed in class before they leave. Finally, these in-class activities form the basis for homework and exam questions.

During my contact time with students, in addition to lecturing and facilitating in-class activities, we also spend time to: (i) talk about what’s involved in being a successful student and successful in their career; (ii) debrief homework and exam questions that proved challenging to the class; (iii) discuss questions, ideas, and experiences that students share through in-class activities and/or in the moment; and (iv) complete three in-class exams, which occur about every 5 weeks and include two mid-term exams and one cumulative final exam.

C.2. Teaching Methods: Outside of Class

Outside of class time, required and optional activities are intended to support student learning. Students are expected to complete a weekly reading assignment and a weekly homework assignment. The rationale for having reading assignments at all is that it (i) facilitates the development of another important professional skill, reading and comprehension of the written word, (ii) makes students responsible independent learners of the straightforward material, and (iii) provides more in-class time to address concepts and material that are more challenging in nature and/or can be enhanced through specific activities or discussion with peers and the instructor. The rationale for having the reading assignments completed on a weekly basis is that it (i) establish a learning routine and (ii) divides the total required reading into many smaller more manageable tasks, which facilitates reduced cognitive load and supports ongoing learning. Similarly, the rationale for having weekly homework assignments is to (i) establish a learning routine, (ii) provide ongoing practice with what they are learning, (iii) provide the option for students to engage in learning on their own or in collaboration with others, and (iv) serve as a vehicle for regular feedback about students’ progress and as the basis for in-class discussion of the most challenging concepts or material in the assignments.

Beyond these basic expectations of reading and homework assignments, students are encouraged to participate in several different optional group activities (e.g., watching and discussing a documentary or participating in a field trip), meet with me during office hours, have email exchanges with me, and participate in periodic review sessions. The rationale for making the optional group activities available is that they directly relate to the course objectives and provide
a natural extension of learning about course-related material outside of the classroom. The rationale for making these additional activities optional is that not every student might be able to take advantage of them due to scheduling and/or related costs. The rationale for making some of these activities group-based is that they are also intended to be opportunities for students to discuss their ideas and questions with others, thus facilitating peer-to-peer learning. Furthermore, the group focus of these activities provides opportunities for students in a relatively large class to get to know each other better, to find study buddies, and to hopefully support each other throughout the semester. Because these group-based activities are aligned with the course objectives and student learning goals, they are also scored and students may earn bonus points towards their overall course grade. In addition, these bonus opportunities are intended to present higher performing students the opportunity to go above and beyond the canned course to further broaden their horizons and present lower performing students the hope and motivation to hang in there when the course feels too challenging or overwhelming for them.

Homework assignments are submitted and assessed online through Blackboard. The questions are mostly multiple-choice in nature and automatically scored; however, open-ended questions are also asked and then manually scored. Optional activities are assessed based on individual write-ups of answers to specific questions posed for the activity and a description of the group discussion upon which the answers were formulated (see Appendix G: Short Paper: Trashed – No place for waste). Meeting during office hours, email exchanges, and participating in review sessions are not formally assessed.

C.3. Course Materials

Course materials that are useful to student achievement of the course objectives and course-level learning goals include the textbook, lectures and in-class activities, homework assignments, study guides, and exams. Table 2 (see next page) summarizes how they should be used in order for students to successfully meet the course objectives and learning goals.

C.4. Rationale for Approach to Teaching

The rationale for my chosen approach to teaching and selected methods for facilitating student learning is discussed in detail under sections C.1 and C.2 above. Students who complete this course successfully are those who achieved the objectives and learning goals. To succeed, they will have used the learning materials in the ways outlined in Table 2 (see next page), made full use of the opportunities to engage in the learning process both in and outside of class, and availed themselves of additional assistance before/after class and/or during office hours. I expect that more students are likely to succeed and succeed at a higher performance level with this interactive lecture approach to teaching than if I were to only lecture at them day to day. This expectation is influenced by my knowledge of research on student learning and the practices that facilitate the learning process (e.g., the theory of constructivism and the centrality of prior knowledge). This expectation could be framed as a testable hypothesis and could be tested if I were teach the same course material using only a traditional approach to teaching based solely on
lecture. However, conducting such a test is likely to not well serve the students in the traditional lecture setting.

<table>
<thead>
<tr>
<th>Material</th>
<th>How student should use material to ...</th>
<th>... achieve these objectives and goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook</td>
<td>- On a weekly basis, read for comprehension.</td>
<td>- Develop reading and reading comprehension skills.</td>
</tr>
<tr>
<td></td>
<td>- Record reading notes.</td>
<td>- Develop note-taking skills while developing a study aid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Distinguish between bogus science and valid science.</td>
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<tr>
<td></td>
<td></td>
<td>- Know the meaning of terms and ideas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Explain key concepts and first principles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Describe methods used by geologists to study Earth.</td>
</tr>
<tr>
<td>Lectures</td>
<td>- On a daily basis, listen for comprehension.</td>
<td>- Develop ability to identify what is important in a lecture.</td>
</tr>
<tr>
<td></td>
<td>- Record lecture notes.</td>
<td>- Develop note-taking skills while developing a study aid.</td>
</tr>
<tr>
<td>In-class activities</td>
<td>On a daily basis, actively engage in learning process by doing the following:</td>
<td>- Develop thinking skills.</td>
</tr>
<tr>
<td></td>
<td>- Focus thinking on the targeted concepts.</td>
<td>- Develop communication skills.</td>
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<td></td>
<td>- Describe thinking by writing, drawing, and discussing.</td>
<td>- Develop collaboration skills.</td>
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<td></td>
<td>- Share thinking with peers, whole class, and instructor through discussion, demonstrations, and presentations.</td>
<td>- Distinguish between bogus science and valid science.</td>
</tr>
<tr>
<td></td>
<td>- Ask questions of peers and instructor.</td>
<td>- Know the meaning of terms and ideas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Explain key concepts and first principles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Describe methods used by geologists to study Earth.</td>
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<tr>
<td></td>
<td></td>
<td>- Apply critical concepts and principles to analyze data and case studies.</td>
</tr>
<tr>
<td>Homework</td>
<td>- On a weekly basis, practice recalling and applying critical concepts and principles.</td>
<td>- Distinguish between bogus science and valid science.</td>
</tr>
<tr>
<td></td>
<td>- Use textbook, lecture notes, and in-class activity handouts as a reference.</td>
<td>- Know the meaning of terms and ideas.</td>
</tr>
<tr>
<td></td>
<td>- Participate in post-homework debriefing session.</td>
<td>- Explain key concepts and first principles.</td>
</tr>
<tr>
<td></td>
<td>- Ask questions of peers and instructor.</td>
<td>- Describe methods used by geologists to study Earth.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Apply critical concepts and principles to analyze data and case studies.</td>
</tr>
<tr>
<td>Study guides</td>
<td>A week prior to exams, follow the advice in the guides to do the following:</td>
<td>- Develop ability to identify what is important.</td>
</tr>
<tr>
<td></td>
<td>- Aid in self-preparation.</td>
<td>- Develop thinking skills and comprehension.</td>
</tr>
<tr>
<td></td>
<td>- Focus on what is important.</td>
<td>- Distinguish between bogus science and valid science.</td>
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<tr>
<td></td>
<td>- Self-test personal understanding.</td>
<td>- Know the meaning of terms and ideas.</td>
</tr>
<tr>
<td></td>
<td>- Work with a study buddy or study group.</td>
<td>- Explain key concepts and first principles.</td>
</tr>
<tr>
<td></td>
<td>- Identify weaknesses in knowledge, understanding, and skills.</td>
<td>- Describe methods used by geologists to study Earth.</td>
</tr>
<tr>
<td></td>
<td>- Ask questions of peers and instructor.</td>
<td>- Apply critical concepts and principles to analyze data and case studies.</td>
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<td></td>
<td></td>
<td>- Further develop thinking, communication, and collaboration skills if used with a study buddy or group.</td>
</tr>
<tr>
<td>Exams</td>
<td>- Every ~5 weeks, test individual ability to recall and apply knowledge and skills developed during the semester.</td>
<td>- Develop ability to identify what is important.</td>
</tr>
<tr>
<td></td>
<td>- Participate in post-exam debriefing session by contributing to the discussion by sharing ideas and questions about the material on which students were tested.</td>
<td>- Develop thinking skills and comprehension.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Distinguish between bogus science and valid science.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Know the meaning of terms and ideas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Explain key concepts and first principles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Describe methods used by geologists to study Earth.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Apply critical concepts and principles to analyze data and case studies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Further develop thinking, communication, and collaboration skills when using a pyramid exam.</td>
</tr>
</tbody>
</table>

Table 2. Course materials and prescribed use for achieving course objectives and learning goals
C.4. Rationale for Approach to Teaching

The rationale for my chosen approach to teaching and selected methods for facilitating student learning is discussed in detail under sections C.1 and C.2 above. Students who complete this course successfully are those who achieved the objectives and learning goals. To succeed, they will have used the learning materials in the ways outlined in Table 1, made full use of the opportunities to engage in the learning process both in and outside of class, and availed themselves of additional assistance before/after class and/or during office hours. I expect that more students are likely to succeed and succeed at a higher performance level with this interactive lecture approach to teaching than if I were to only lecture at them day to day. This expectation is influenced by my knowledge of research on student learning and the practices that facilitate the learning process (e.g., the theory of constructivism and the centrality of prior knowledge). This expectation could be framed as a testable hypothesis and could be tested if I were to teach the same course material using only a traditional approach to teaching based solely on lecture. However, conducting such a test is likely to not well serve the students in the traditional lecture setting.

D. THE COURSE & THE BROADER CURRICULUM

D.1. Existing Curriculum

With respect to the department curriculum, this course is essentially a stand-alone 100-level course as it currently has no lab, no pre-requisites, and no sequenced course that follows it. As such my choices of methods, materials, and activities do not build upon what students have learned in previous courses offered through my department. They also do not prepare students to take a specified more advanced course(s) through my department.

Nevertheless, my choices of methods, materials, and activities, do provide general preparation for future courses and professional endeavors beyond graduation. In addition, they prepare students to meet the broader university curriculum with respect to satisfying the ACE 4 requirement. The ACE 4 requirement states that students will: Use scientific methods and knowledge of the natural and physical world to address problems through inquiry, interpretation, analysis, and the making of inferences from data, to determine whether conclusions or solutions are reasonable.

This course may be used as a substitute for Introduction to Geology for those who change their major to geology on a case by case basis; as such, it is important that there be a significant amount of overlap between this course, GEOL 106: Environmental Geology, and the Introduction to Geology course (i.e. a physical geology course).
D.2. Future Curriculum

Although GEOL 106 currently fits into the Departmental curriculum to primarily serve students seeking to satisfy a the ACE 4 general education requirement and/or their own personal curiosity about geology, this will change when the Department implements a new undergraduate major in geoscience (which will be added to the two existing majors, geology and meteorology) as well as the introduction of a new GEOL 106L: Environmental Geology Lab course.

The shift from the course primarily being a stand-alone course for non-STEM majors to a course that will also be a key part of the new geoscience major gives rise to questions such as: What are the learning goals of the new major? What courses and sequence of courses will geoscience majors be required to take? What type of background and skills will they need to have developed in GEOL 106 to prepare them for the courses to come? Answers to these questions will eventually form the basis for potential future revisions to how I’ve designed GEOL 106 to for the time being meet the needs of non-STEM majors fulfilling an ACE 4 requirement.

E. ANALYSIS OF STUDENT LEARNING

E.1. Capturing Snapshots of the Teaching & Learning

To capture snapshots of the teaching and learning that happened in this course, it is useful to connect the instructor and student performance to the pre-defined course objectives and student learning goals. Table 3 (see next page) connects (i) the student learning goals and course objectives (see Table 1 for details associated with each numbered goal/objective) to (ii) a particular concept and (iii) examples of activities used to address those concepts prior to or during explicit instruction, and (iii) indicates how learning of this concept was assessed after instruction.

To make convincing claims of what students do and do not learn from a course, it is first minimally necessary to determine what the students already know and are able to do before the course begins and compare that with what they know and can do at the end of the course. Pre/post knowledge tests, concept inventories, and attitudinal surveys are examples of the types of assessment instruments that lend themselves well to a systematic analysis of student learning. For this course, I do not yet have a pre/post knowledge test or concept inventory, but I do have a pre/post attitudinal survey.

Although I am still in the process of developing a pre/post knowledge test and concept inventory for this course, other types of assessments can be used to gain some insights into the student learning and teacher effectiveness that occurred in this course. Table 3 highlights examples of assessments that are aligned with learning goals and course objectives used to gain insights into what students know before/during instruction and after participating in learning activities. It is worth noting here that the in-class activities earlier described serve as formative assessments.
Referring to Table 3, for the purposes of this benchmark portfolio, I will provide a brief activity-level analysis of student learning by examining how three specific concepts were addressed (with only one selected activity) and assessed with respect to their associated student learning goals. The course concepts are climate change impacts on the global community (#3 in Table 3), porosity and permeability (#4 in Table 3), and floods and flood probability (#5 in Table 3). For the student learning goals associated with these three examples, refer to Tables 1 and 3. In addition, to providing a brief activity-level analysis of student learning, I will also provide a brief course-level analysis of student learning. This course-level analysis will examine aggregated student data and comment on the overall cognitive and affective development that took place in students during their time in this course.

E.2. Activity-Level Analysis of Student Learning

In order to assist students in learning important concepts about Earth processes, Earth phenomena, how they influence life on Earth, and how humans can impact these Earth processes and phenomena, I strive to provide students with opportunities to actively engage in thinking about and discussing these ideas. These opportunities are regularly linked to in-class activities. Below, I succinctly describe three of these activities, how they are implemented, and how learning of the target concepts is assessed. The activities described include (i) Case Studies: Climate Change Impacts on the Global Community, (ii) Interactive Lecture Demonstration: Porosity and Permeability, and (iii) Lecture Tutorial: Floods and Flood Probability.
E.2.a. Case Studies: Climate Change Impacts on the Global Community

In this course, the majority of the geologic examples discussed throughout the semester were drawn from situations in Nebraska or, more broadly, in the United States. This case studies activity was intended to stimulate the development of a more global perspective among individual students, increase their knowledge of the impacts of climate change on other nations, to practice and further develop their collaborative skills, and to build a community-originated base of knowledge. Through this activity, students formed teams around a specific country and they were tasked to use any available resource (including the internet) to identify and share one to three key economic sectors of that country, one to three key environmental concerns confronting that country, and the actual or possible responses their government could have to dealing with those environmental concerns.

This in-class activity took place during the last week of the semester over the course of three class meetings. In the first class meeting, teams of three to four students each were formed based on students’ interest in a specific country, and then the teams had time to discuss how to approach this activity, divide the work, and begin doing the research. In the second class meeting, teams completed their research and began presenting their findings with the class. Each team had approximately five minutes to share their findings with their classmates. Examples of the student group presentations are included in Appendix F. Teams received full marks for demonstrating good faith effort in sharing accurate information addressing the three research areas and in clearly presenting this information to their classmates.

Insights into the potential impact that this exercise had on student learning can be gleaned from their performance on the associated homework assignment and their responses to the post-activity reflection exercise about their small group discussions and work.

*Insights into Student Learning Based on Performance in Answering Homework Questions*

The homework assignment assigned during the week where the students completed this in-class activity had eight multiple-choice questions that were based on the information presented in the student presentations. A subset of these eight questions was selected for analysis in this benchmark portfolio. The subset is composed of three questions that illustrate a range of collective class performance.

The three questions are provided below. The percentage of the class that selected each possible answer choice is indicated in parentheses. The choice that is bolded represents the best answer of the choices provided. Forty-eight students out of 56 students completed this particular homework assignment (i.e., 86% of the class).
Q.1. Of the countries discussed during the presentation of each team's international case study, which country is becoming more overrun with desert lands? In other words, which country is experiencing extensive desertification?

(A) Saudi Arabia (94%)
(B) Vanuatu (0%)
(C) China (6%)
(D) Netherlands (0%)
(E) Germany (0%)

Q.2. Draw on common knowledge, what you learned this semester, as well as what you learned from team Brazil this week to answer this question. Deforestation of the Amazon Rainforest is a point of concern for which one(s) of these reasons?

(A) Loss of valuable top soil (2%)
(B) Higher amounts of atmospheric carbon dioxide (4%)
(C) Loss of biological diversity that does not live anywhere else in the world (0%)
(D) A & B (6%)
(E) A, B, & C (88%)

Q.3. Of the countries discussed during the presentation of each team's international case study, which country is a global leader when it comes to developing and using green technologies and clean energy?

(A) Brazil (0%)
(B) China (13%)
(C) Netherlands (10%)
(D) Vanuatu (0%)
(E) Germany (77%)

These questions fall under the “knowledge” category of Bloom’s taxonomy (for more information go to http://www.coun.uvic.ca/learning/exams/blooms-taxonomy.html). This category in Bloom’s taxonomy represents the lowest level of cognitive ability (i.e. simple recall of information). The vast majority of the class, between 77% and 94%, answered these “knowledge” questions correctly. This is in marked contrast to class performance in answering “knowledge” questions based on the reading assignments that appeared in both homework assignments and the exams. Reading assignments address straightforward basic information that students should comprehend without assistance (thus, allowing time in class to address more complex and challenging concepts). Nevertheless, class performance on reading-related questions is generally low. Based on information that students shared during class discussions during homework reviews as well as the mid-semester and end-of-semester questionnaires, it is apparent that students neglect to complete the reading assignments even when they are directly linked to the homework and exams. The very high class performance on the “knowledge” questions based on the student case studies and presentations suggests that this approach is a more effective mechanism at promoting student thinking at the lowest level of Bloom’s taxonomy. Furthermore, their high performance on these questions is partial evidence that the content-related goals of this activity were achieved.
Insights into Student Learning Based on Responses to Post-Activity Reflection Exercise

The post-activity reflection exercise was comprised of five different questions, each with one or more parts. The questions were posed in order to have individuals reflect on their experience working with their peers in a small group. Below is a subset of the questions posed. A summary of the student responses is provided below each question. The number of students who made each evaluation is listed after the comma and the percentage of the class that completed this exercise is indicated in parentheses. Below each answer choice is one representative example of actual student responses that supported their evaluation. Forty-six students out of 56 students completed this reflection exercise.

Q.1. How well do you think the other members of your team allowed you the opportunity to contribute to the research effort and discussion? Circle one of the choices below:
(A) Extremely well, 19 (41%)
   - We split the work we each brought our own individual findings, and sometimes somebody else found more interesting information than what we had before.
(B) Very well, 22 (48%)
   - I think the group did a good job listening to mine and other members’ findings.
(C) Fairly well, 2 (4%)
   - [neither student wrote a response]
(D) Not well, 1 (2%)
   - Share knowledge of what they learned outside of class.
(E) Extremely poorly, 2 (4%)
   - A couple of us just kind of did it. It was easier that way.

Q.2. Overall, how helpful/useful was it to meet with your classmates in a smaller group to learn about another country’s economic and geographic conditions and their associated environmental issues?
(A) Extremely useful, 7 (15%)
(B) Very useful, 22 (48%)
(C) Fairly useful, 13 (28%)
(D) Not useful, 3 (7%)
(E) Completely useless, 0 (0%)
(F) Blank, 1 (2%)

Q.3. What were two of the most helpful/useful things you got out of your small group discussion?
(The five student responses below are representative of the range of answers provided to this question.)
- I had never heard of [country] before so it was interesting to learn about a new country. I am really interested in environmental issues countries are facing and ways we can restore ecosystems.
- Learning about other countries from other people instead of the internet/text book.
- Overall collaboration.
- During the discussion, find a new way to solve the problem.
Based on student responses to this reflection essay, the vast majority thought that their team functioned well, they were able to contribute in meaningful ways to their team’s discussion and work, and they found this activity useful to their learning.

E.2.b. Interactive Lecture Demonstration: Porosity and Permeability

Porosity and permeability are two fundamental concepts in the field of geology that have applications to, for example, fluid transport and storage in the subsurface. To facilitate student learning about the fundamental concepts of porosity and permeability, one of the strategies that I use is an interactive lecture demonstration. Given that this course is taught in a large auditorium, it is not possible to run a real-time demonstration that deals with porosity and permeability of actual geologic samples at the front of the class in such a way that it would be visible to any of the students. To work around this potential limitation, I video recorded the demonstration at home and, in class, I play the video on the large projector and pause it at key moments to give students time to think, predict what will happen, write down their prediction, observe, and record their observations.

To facilitate this activity, students are given a short worksheet to record their predictions and observations. Before playing the video, they are asked to individually predict what will happen with each of the geologic samples and write down their predictions. As a class, we then discuss their predictions and see how many people share common predictions. After this discussion, students are asked to watch the videoed demonstration and record their observations. After watching the videoed demonstration, as a class, we discuss what they observed, whether their predictions bore out in their observations, and why or why or why not there is dis/agreement between individual predictions and observations. Examples of students’ completed worksheets are included in Appendix E. Students received full marks for demonstrating good faith effort in clearly writing down what they predicted and observed and answering the additional questions on the worksheet.

Insights into the potential impact that this activity had on student learning can be gleaned from their performance on questions related to porosity and permeability in the homework assignment for that week. The homework assignment assigned during that week has three multiple-choice questions that addressed these concepts. The three questions are provided below. The percentage of the class that selected each possible answer choice is indicated in parentheses. The choice that is bolded represents the best answer of the choices provided. Forty-nine students out of 56 students completed this particular homework assignment (i.e., 88% of the class).

Q.1. ____(i)__ has very low permeability; whereas, ____(ii)__ has very high permeability.
(A) (i) clay, (ii) gravel (80%)
(B) (i) gravel, (ii) clay (12%)
(C) (i) sand, (ii) shale (4%)
(D) (i) highly fractured granite, (ii) unfractured granite (4%)
Q.2. Apply your knowledge of rock types, porosity, permeability, and aquifers to answer the following question. Which one of the following is the most ideal aquifer for drilling a well into for the purpose of extracting drinking water?

(A) A limestone cave partially filled with water (6%)
(B) A thick impermeable layer of shale (10%)
(C) Fractured quartz sandstone that is saturated (78%)
(D) Unfractured marble (6%)

Q.3. An aquifer composed of ____ will have the greatest porosity compared to aquifers composed of the other materials listed.

(A) Well sorted sand grains (24%)
(B) Well sorted gravel grains (49%)
(C) Poorly sorted mixture of sand and gravel grains (27%)
(D) Unfractured granite (0%)

The results of Q.1 above provide evidence that the class has a strong understanding of permeability. The results of Q.2 also provides such evidence; however, the evidence would be more compelling if the correct answer did not contain the words, “that is saturated” in it. When compared with the results from Q.1 and Q.2, the results of Q.3 provide evidence that the class has less of an understanding of what porosity is.

E.2.c. Lecture Tutorial: Floods and Flood Probability

One way to facilitate the development of students’ ability to apply critical concepts and first principles to analyze data and case studies is to use lecture tutorials. A lecture tutorial is used to aid students in learning about floods and flood probability. The lecture tutorial that we use is a modified version of one written by Kortz and Smay (2010) and is included in Appendix D.

After listening to a lecture and participating in whole class discussion of key questions, the students are asked to work in pairs on the lecture tutorial. As they do, I circulate around the auditorium to see how they are progressing and help them work through questions that emerge in their paired discussions. When students are finished with the lecture tutorial, we quickly go through the “easier” questions as a class so that individuals can compare their answers to the best possible answers. For the questions that involve calculations, volunteers come up to the front of the class and present their solutions for discussion and potential revision by one or more other volunteers. At the end of this activity, students are asked to hang onto this lecture tutorial and use it as a reference for completing the next homework assignment and as a study tool to prepare for the next exam.

Insights into the potential impact that this exercise has on student learning can be gleaned from their performance on questions related to flooding on the first exam. The isomorphic pair of mid-term exam questions asked in the two different versions of the first exam are included below, along with their data of class performance and the Testing Center’s item analysis of the test question (in blue box). Although 58 students completed Exam 1, only 52 students completed it in class (the remainder completed the exam in the Office of Services for Students with
Disabilities or in my office). Only the 52 responses collected during the in-class exam are discussed below.

Mid-term Exam 1, version A, n=27
Q. If Little Oak River has a flood every 100 years that has a stage of 30 feet and a discharge of 30,000 cubic-feet per second, what are the chances that another flood with the same stage and discharge will occur in the year 2020? In other words, what is the percent probability?

(A) 1%  (52%)
(B) 2%  (4%)
(C) 10% (37%)
(D) 20% (2%)

Difficulty = 0.52 Discrimination = 0.61 Correlation = 0.51
This question is a good discriminator.
It has high correlation.

Mid-term Exam 1, version B, n=27
Q. If Little Oak River has a flood every 10 years that has a stage of 30 feet and a discharge of 30,000 cubic-feet per second, what are the chances that another flood with the same stage and discharge will occur in the year 2020? In other words, what is the percent probability?

(A) 1%  (15%)
(B) 2%  (7%)
(C) 10% (74%)
(D) 20% (4%)

Difficulty = 0.74 Discrimination = 0.75 Correlation = 0.58
This question is a good discriminator.
It has high correlation.

Although these two questions were intended to be isomorphic, the difference in the percentage of students answering version A and version B correctly is statistically significant. This suggests that version B resulted in a higher percentage of students answering the question correctly compared to version A because of the difference in wording. Therefore, for the purposes of understanding student abilities with respect to calculating the percent probability, the results to version A are likely to be more insightful. Based on the results to version A, it appears that a little more than half of the students who answered this question knew how to complete the calculation correctly. This suggests that students need more practice solving these types of problems. In addition to providing more practice with these types of problems, I also need to revise version B so that “10” is not in the question. Making this change will, hopefully, result in student responses to these isomorphic questions that are more similar than they were this semester.

E.3. Course-Level Analysis of Student Learning

This course has two defining course-level objectives (see Table 1) or intellectual goals. Combined, these two objectives address individual student development in terms of both the cognitive domain (i.e., thinking skills and abilities) and affective domain (i.e., attitudes and beliefs). The cognitive and affective elements of these two course objectives are addressed in the design and implementation of the learning opportunities/activities, such as those previously described. Insights into student cognitive development are based on student performance in formative assessments (such as the aforementioned activities) and summative assessments such as exams; whereas insights into student affective development can be gleaned from the results of
a pre/post attitudinal survey. Below I present a brief analysis of summative data that provides insights into student cognitive development and pre/post data that highlights the changes in student affective development, which occurred between the first and last week of the course.

1. Analysis of Cognitive Development

Given that I have not yet developed a pre/post knowledge test or concept inventory for this course, it is not possible to make strong claims about the actual learning gains that might have taken place during the semester. Nevertheless, we can examine the class’s performance on the three exams and on the three progress checks that occurred during the semester. The scores for only 56 of the original 58 students that enrolled in the course are analyzed here because two of the students dropped the course. Based on conversations with these two students, one dropped the course because of extenuating personal circumstances and the other dropped it because the student found the course to be too difficult.

The first two exams cover the content from only the five to six weeks immediately preceding the exam; the third exam is cumulative and covers the content from all 15 weeks of the semester. The rationale for having the final exam be cumulative is that the content discussed in the final third of the semester is intimately connected to the content of the first two thirds of the semester; students, therefore, need to know and be able to make these connections. Figure 1 shows the distribution of student scores for each of the exams.

Figure 1. Class distribution of exam scores

Inspection of student performance shows two students have test scores below 40% for Exam 2 and three students have test scores below 40% for Exam 3. If the assumption is made that these students are a part of the course but not invested in the course, then their scores may be omitted to determine the class average for the students invested in the course. When this is done, then the corrected averages are 77%, 68%, and 71%, respectively. These averages better mirror the downward shifting peak from Exam 1 to 2 and the upward shifting peak from Exam 2 to 3.
There are two mid-semester progress checks, and each is provided to students one week after each of the mid-term exams. These progress checks represent the students’ course grade up to that point in the semester. The third progress check represents the students’ final course grades. Figure 2 shows the distribution of student scores for each of the progress checks. Inspection of student performance shows one student has a progress check score below 40% for Progress Check 2 and two students have scores below 40% for Progress Check 3. If the same assumption is made as above, then the corrected averages for Progress Check 1, 2, and 3 are 78%, 74%, and 75%, respectively.

![Figure 2](image)

**Figure 2.** Class distribution of progress check scores. Each progress check represents a student’s course grade up to that point in the semester (i.e. the total points the student earned out of the total possible points up to that point in the semester).

As with Figure 1, Figure 2 shows an apparent downward shift in peak between Progress Check 1 and Progress 2 followed by an apparent upward shift in peak between Progress Check 2 and Progress Check 3.

The apparent decline of student performance on the exams and progress checks are correlated with a general decline in student participation (determined by number of in-class activities submitted) and completion of homework assignments. Figure 3 highlights the decline in class participation between the first day of class and the day that Exam 2 was administered. The linear regression of the data during this time is represented by the following equation: \( y=-0.2+8325 \). Exactly one week after Exam 2, I share a similar graph with the class and we discuss the patterns. In particular, we note (i) the decline in class participation is correlated to the decline in the average exam scores for Exam 1 to Exam 2 and (ii) class participation is consistently lower on Fridays when compared to class participation on Mondays and Wednesdays. During this discussion, I also highlight for them the fact that in-class activities, homework, and exams are the major categories of work that inform their final course grades. It is noteworthy that class
participation following that day does not dip lower than the class participation for the day that we have this class discussion. The general improvement in class participation during the final third of the semester might be partially attributed to this class discussion; it might also be attributed to students trying to earn as many in-class activities points as they could before the end of the semester.

On a related note, two final exam review sessions are scheduled one and two weeks prior to the final exam. This semester, during one of these review sessions, a couple of students indicated that the second exam was much harder than the first exam and we discussed the reasons why they thought this. After listening to their ideas, I shared with them some information to consider when trying to explain the decrease in performance between the first third and the second third of the semester. The information included that (a) the questions on Exam 2 were written in the same style and format as those in Exam 1, (b) they had the same opportunities to practice questions on Exam 2 during class time and on homework assignments as they did with Exam 1, and (3) there was a significant decrease in class participation from the start of the semester to the date of Exam 2. I then shared my idea for why Exam 2 scores were lower than Exam 1: Given that the Exam 2 questions were in the same style and format as Exam 1 questions and given that they were provided the same number and kind of opportunities to practice applying what they learned during in-class activities and homework assignments as they did with Exam 1, I saw the main difference being the level of class participation and perhaps the amount of time students spent preparing for Exam 2. I also suggested that perhaps students felt that they didn’t need to study as much for Exam 2 as they did for Exam 1 because the class average was 77% on Exam 1. After I shared my perspective, most of the students at the review session confirmed that they had in fact spent less time preparing for Exam 2 than they did for Exam 1.

Figure 3. Class distribution of progress check scores. Orange symbols represent Fridays. Green symbols represent exam days. The Friday with the lowest student presence in class was the Friday immediately before the Spring Break.
2. Analysis of Affective Development

During the first week of the semester, students are asked to answer survey questions about their attitudes towards science and learning science. Their responses help me to better understand the individual students in the class very early on. In the last week of the semester, students are again asked to answer survey questions. There are 18 common attitudinal questions asked at the beginning and at the end of the semester. These questions are modified from the C-LASS survey, validated for physics courses. Mine is an informal survey and has not been tested for validity and reliability.

Comparing the aggregated class data for the responses to each of these 18 questions before and after a semester’s worth of instruction provides an indication of shifts in attitudes about science and learning science. Table 4 lists the questions and shows what shifts in attitude, if any, occurred over the course of the semester. Fourteen out of the 18 questions are associated with shifts towards more expert-like attitudes; of these 14 shifts, 9 of them are greater than 9%. Four out of the 18 questions are associated with shifts towards more novice-like attitudes; however, none of the shifts towards more novice-like attitudes is greater than 9%.

Based on this comparison of the results for the pre- and post-instruction attitudinal surveys, this course has an overall positive impact on the development of students’ attitudes towards science and learning science. Most notable are students’ intentions to use their newly gained knowledge of Environmental Geology to help them make personal and professional decisions. Also notable is an improved self-perception of their ability to identify important themes or concepts while listening to others; derive meaning from diagrams, graphs, and maps; and to learn science (in fact, many more people described themselves as a “science person” at the end of the course than at the beginning). Students also came away from the course with a better understanding of the nature of science and with a much more positive attitude towards working with others.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>SHIFT TOWARDS</th>
</tr>
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<tbody>
<tr>
<td>Q.1 I am interested in learning about the interactions between humans and the environment.</td>
<td>more expert</td>
</tr>
<tr>
<td>Q.2 I am interested in learning about how scientists study geologic aspects of the environment.</td>
<td>more expert</td>
</tr>
<tr>
<td>Q.3 I am interested in learning about how scientists make &quot;predictions&quot; related to hazards.</td>
<td>no change</td>
</tr>
<tr>
<td>Q.4 I plan to use knowledge of Environmental Geology in my future academic and/or career plans.</td>
<td>more novice</td>
</tr>
<tr>
<td>Q.5 I plan to use knowledge of Environmental Geology to help me make personal and professional decisions.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.6 I am able to make mathematical conversions (e.g. converting miles to kilometers).</td>
<td>more expert</td>
</tr>
<tr>
<td>Q.7 I am able to examine and derive meaning from diagrams, graphs, and maps.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.8 While listening to others, I am able to identify important themes or concepts.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.9 I can take class notes that are useful to me when preparing for exams.</td>
<td>more expert</td>
</tr>
<tr>
<td>Q.10 I am able to draw simple sketches or diagrams to explain what something looks like or how a process works.</td>
<td>more novice</td>
</tr>
<tr>
<td>Q.11 I am a &quot;science person&quot;.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.12 I am NOT a &quot;science person&quot;.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.13 Anyone can learn science if they work at it.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.14 The process behind science is very clear-cut and black &amp; white.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.15 The process behind science is very creative.</td>
<td>more expert</td>
</tr>
<tr>
<td>Q.16 There is one straightforward approach to finding credible and accurate answers to scientific questions or problems.</td>
<td><strong>more expert</strong></td>
</tr>
<tr>
<td>Q.17 I like to work alone.</td>
<td>more expert</td>
</tr>
<tr>
<td>Q.18 I like to work with others.</td>
<td><strong>more expert</strong></td>
</tr>
</tbody>
</table>

**Table 4.** Shifts in attitude about science and learning science. ** indicates shifts that are greater than 9%.  n_{pre}=55 and n_{post}=52.
F. PLANNED CHANGES

As a result of my experience in the Peer Review of Teaching process, I plan to do the following:

(i) Develop a draft of a pre/post knowledge test or concept inventory.
(ii) Use item analyses of exam questions to refine them.
(iii) Develop a plan to aid students in better understanding probability (e.g. flood probability).
(iv) Continue to develop new and refine existing learner-centered activities.

G. SUMMARY ASSESSMENT OF PORTFOLIO PROCESS

Through the Peer Review of Teaching benchmark portfolio process, I had experiences that will help me to be a better teacher at UNL. The experiences that I had helped me to (i) meet other faculty members and become more integrated into the UNL faculty community, (ii) see how my course fits into the larger course offerings at UNL, and (iii) reinforce the areas that I’d like to further develop in the course. I had the opportunity to meet other faculty members from many departments at UNL and therefore to become more integrated into the UNL community. I especially enjoyed learning about the wide range of courses offered, how some of them are currently being taught, and how the course that I targeted for this benchmark portfolio might interface with other courses. For example, I learned that my course has the potential to dovetail nicely with the requirements of engineering students and journalism/mass communications majors. In addition, I was able to learn from other faculty members how they are thinking about their own courses and what they are doing to facilitate student learning. I especially enjoyed the conversations where we shared what we do in our classes, how we decided to approach teaching and learning the way we do, and what ideas we might try applying to our teaching in the future. These were particularly inspiring and motivating conversations. Lastly, participating in this benchmark portfolio process further confirmed/strengthened my desire to develop a pre/post knowledge test or concept inventory, refine the formative and summative assessments, and continue developing learner-centered activities intended to facilitate student learning.
Appendix A

Course Syllabus
GEOL 106: Environmental Geology
MWF 2:30-3:20, Bessey Hall Room 117, 3 credit hours

Instructor: Dr. Leilani Arthurs, Department of Earth and Atmospheric Sciences

Office Hours: 11:00AM – 1:00 PM Thursday or by appointment in Bessey Hall, Room 330

e-mail: larthurs2@unl.edu

Website: The course will use the Blackboard website, which can be accessed through your My.UNL account. For questions and technical problems, contact the Help Center at (402) 472-3970, or toll-free at (866) 472-3970.


GEOL 106 is an Achievement-Centered Education (ACE) course required for UNL graduation. See page 6 for details.

Background
In the past 20 years or so, there has been increasing recognition that Planet Earth is best thought of as an Earth system. This Earth system is composed of the inter-connected geosphere (the solid earth), hydrosphere (oceans, glaciers & ice sheets, fresh water), atmosphere, and biosphere. A change in any one component of the system can impact the other components. The realization that we live in a complex interdependent system now drives interdisciplinary research where geologists, for example, work side-by-side with biologists and physicists on a single question.

The other remarkable change that has only recently become apparent is the role of humans in this system. Humans are no longer considered passive inhabitants on Planet Earth. We know that human activity is changing the composition of the atmosphere, and altering the surface characteristics of the continents, particularly in the world’s primary agricultural regions. We know that our activities continue to alter the composition and distribution of the global biota. What we are less sure of is the consequences of these impacts. We want to know if our activities will have a negative long-term impact on the ability of Planet Earth to sustain life, and particularly to sustain human civilization. Naturally, this is the subject of current interest to researchers in a wide variety of disciplines.

Course Description & Expectations
The primary objective of this course is to provide students with the opportunity to grow and develop habits of mind that will aid them in their journey of life-long learning and their role as scientifically savvy citizens. The secondary objective of this course is to discuss the interaction between Earth processes and humans’ current ways of living through inspection of environmental issues including natural disasters, natural resources, and environmental impacts. Students will learn (a) about Earth processes over which humans have little or no control, (b) how human life and the built environment are dependent on the natural environment, and (c) about the impact that human actions have on the Earth system.

The course will stress scientific methods used to evaluate problems of regional and global concern. The course will involve simple algebraic manipulations and data analysis. The emphasis is on understanding critical concepts or fundamental principles and how they are applied in understanding issues of current environmental relevance.
**Overall Course Learning Outcomes**

Upon successful completion of this course, students will be able to:

1. Use successful learning strategies, inc. collaboration with peers and note-taking skills.
2. Distinguish “good science” from “bogus science”.
3. Know the meaning of important terms and facts relevant to environmental geology.
4. Explain critical concepts and first principles relevant to environmental geology.
5. Apply critical concepts and first principles to analyze data and case studies.
6. Describe methods used by geologists and other scientists to study the Earth system.

**Approach to Course & Responsibilities**

Deep learning is an active process based not only on focused independent effort but also productive interactions with peers and teachers. Key factors for successful learning include opportunities to practice and receive timely feedback. This course is therefore structured in a way that provides opportunities for active engagement through in-class activities, discussion, and homework. Material covered during class time will not directly overlap with the assigned readings; therefore, students will be most successful in the course if they both do the reading assignments AND attend class.

Rest assured that I will do my part to support you and your learning efforts. You, however, must also do your part. As an adult learner, you are responsible for taking the initiative to participate, complete course work, and study for exams. This means that YOU determine how much you learn and YOU determine your course grade – I only add up the points that you earn.

**Blackboard & E-mail**

Class announcements and assignments will be posted on Blackboard.

If you would like to send me an email, then use my email address provided on page 1. Also:

1. Use your unl.edu email address to send the message.
2. Include as part of the subject line the words “GEOL 106, Spring 2013”
3. Be sure to include your first and last name as part of the message you write.

**Student Conduct Code, Academic Misconduct, and Inappropriate Classroom Etiquette**

The University of Nebraska at Lincoln is a learner-centered university and embraces a campus and learning environment based on civility and mutual respect among members of the campus community. UNL’s *Student Code of Conduct* outlines inappropriate conduct including, but not limited to, academic dishonesty, classroom disruptions, disorderly conduct, threats, and assault.

Academic dishonesty will not be tolerated in this class. Dishonesty includes, but is not limited to, plagiarism, unauthorized notes brought into an exam, copying answers from another student, and letting another student copy your answers on exams. Students are referred to UNL’s *Student Code of Conduct* for further details. The penalty for the first offense will be a **grade of zero points** on the exam. Penalty for the second offense will be an **F in the course**.

Inappropriate classroom etiquette will also not be tolerated in this class. Inappropriate classroom etiquette includes, but is not limited to distracting behavior during lecture such as entering late, leaving early, chatting, phone alerts, texting, and laptop use for anything else besides note-taking. When someone in an audience is chatting (even in a low voice), texting, emailing, surfing the net, etc., it can be very distracting to those nearby and can prevent them from getting the most out of being in class that day. In addition, I will find it distracting and particularly rude if I see you wearing headphones or earbuds. If you disrupt class in any of these ways, you will receive a warning the first time. A second offense will result in a **10% reduction in your final grade**. *Students who use a laptop for note-taking must meet with me during the first week of classes to discuss this and sign a laptop use agreement.*
**Collaborative Work**

Other than for exams, working with classmates outside and during class time is encouraged. The following guidelines are intended to show where the line is drawn between productive collaborative learning and academic dishonesty:

1. Please DO discuss possible answers with other students.
2. Please DO use your own wording when composing open-ended essay-like answers.
3. Do NOT copy answers from another student. If you want to adopt the same answer as another student, then be sure to know why you are picking that answer.
4. Do NOT knowingly allow another student to copy your answers. If you want to share your answer with another student, then be sure you both understand why the answer is probably correct.

**Class Format & Major Policies**

1. **Classroom Environment**: Creating a respectful, safe, and even fun classroom learning environment is the responsibility of all of us. This involves, but is not limited to, coming to class on time; staying for the entire class period; being mentally present, attentive, and ready to learn; listening to those discussing a point; recording notes of what is being discussed; thinking about what is discussed; asking questions; and sharing your ideas.
2. **In-Class Activities**: I will keep your completed in-class activities. Assuming good faith effort, you will in general receive full credit for turning in a completed in-class exercise.
3. **Missing Class**: No provisions are made for making up in-class exercises.
4. **Weekly Homework**: HW will be completed online. These will be posted on Blackboard by 6:00 PM on Friday. HW will generally be comprised of 5-10 questions and the deadline for submission is 6:00 PM Sunday (i.e. 2 days after the HW is posted). The exception to this policy is HW 1a. HW 1a is an online questionnaire that students should complete by 6:00 PM on Fri. Jan. 11 OR within 2 days of adding the class if they were not enrolled by Fri. Jan. 11. When computing your overall course grade, your lowest HW score will be dropped.
5. **Late HW**: Late HW receives a 10% deduction for every day that it is overdue. In order to turn in HW late you must contact me via email to let me know your situation and to receive the HW. Up to three late assignments will be accepted per individual.
6. **Exams & Exam Dates**: Exams will be primarily multiple-choice and administered in-class. Mid-Term Exam 1 ...... Feb. 15 ......................... covers Parts I and II of course (see schedule)
   Mid-Term Exam 2 ...... Mar. 29 ......................... covers Part III of course (see schedule)
   Final Exam .................. April 30, 1:00-3:00 PM ... covers Parts I-IV of course (see schedule)
7. **Missing Exams**: Given that exams are scheduled well in advance, students must speak with me two weeks before the exam date and make-up exams will be scheduled only if you provide evidence of extenuating circumstances (e.g. a signed doctor’s note stating a health emergency, etc. Doctors’ notes MUST include their contact information). Make-up exams will be ESSAY.
8. **E-communication**: E-mail is the preferred means of communication between you and the instructor. Your **unl.edu** e-mail account is the account through which you will receive all university-related communications. It is your responsibility to forward all e-mails sent to your **unl.edu** account to the e-mail account that you will check on a regular basis. Class announcements will be posted on Blackboard.
9. **Course Schedule**: The course schedule may be subject to change. Changes to the schedule will be announced in class and on Blackboard.
10. **Copyrights**: The materials used in this course are copyrighted. By “materials”, I mean everything prepared and used for this class, which includes but are not limited to the syllabus, homework, and exams. Because they are copyrighted, you do not have the right to copy and distribute them (e.g. to individuals or online companies) unless I personally grant permission.
**Students with Disabilities**

Students with disabilities who qualify for academic accommodations should obtain a letter from the office of Students with Disabilities Services and discuss specific needs with me in the first week of the semester. SDS determines accommodations based on documented disabilities (Contact: 472-3787).

**Religious Obligations**

Students with conflicts between religious observance dates and course exams or assignments must notify me via email at least two weeks in advance of the event so that reasonable and appropriate accommodations can be arranged.

**Library Resources**

UNL has nine libraries. They are treasure troves of information. You can learn more about our library resources at [http://libraries.unl.edu/](http://libraries.unl.edu/)

**Important Dates**

- **Jan. 14**: Last day to drop and receive 100% refund
- **Jan. 18**: Last day to drop and receive 75% refund (drops after this are part of record)
- **Mar. 17-24**: Spring Break – No classes
- **Mar. 21**: Last day to withdraw
- **Apr. 27**: Last day of classes

**Grading**

Your final class grade will be determined by your performance in the four different areas listed below. Please note that the points listed are subject to change. Potential changes, however, will NOT dramatically change the contribution of each area to the final course grade.

<table>
<thead>
<tr>
<th></th>
<th>How many</th>
<th>Points / each</th>
<th>Total Points</th>
<th>Contribution to Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Class Exercises</td>
<td>44</td>
<td>2</td>
<td>88</td>
<td>20%</td>
</tr>
<tr>
<td>Weekly Homework</td>
<td>13</td>
<td>10</td>
<td>130</td>
<td>29%</td>
</tr>
<tr>
<td>Mid-Term Exams</td>
<td>2</td>
<td>75</td>
<td>150</td>
<td>34%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>1</td>
<td>75</td>
<td>75</td>
<td>17%</td>
</tr>
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</table>

Your final course grade will be assigned based on the total points you earn out of a max of 443 points. Below is a table that corresponds the number of points earned with the final letter grade.

<table>
<thead>
<tr>
<th>Total Points You Earned</th>
<th>% of Points Earned</th>
<th>Letter Grade Earned</th>
<th>Level of Performance Associated with Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>399-443</td>
<td>90-100%</td>
<td>A- to A+</td>
<td>Excellent – mastery of the material</td>
</tr>
<tr>
<td>354-398</td>
<td>80-89%</td>
<td>B- to B+</td>
<td>Very good – not completely mastered</td>
</tr>
<tr>
<td>310-353</td>
<td>70-79%</td>
<td>C- to C+</td>
<td>Average – fair understanding</td>
</tr>
<tr>
<td>266-309</td>
<td>60-69%</td>
<td>D- to D +</td>
<td>Poor – weak understanding</td>
</tr>
<tr>
<td>0-265</td>
<td>&lt;60%</td>
<td>F</td>
<td>Failing – poor understanding</td>
</tr>
</tbody>
</table>

Letter grades for the course will be assigned as follows: A+ = 97% and up, A = 93-96%, A- = 90-92%, B+ = 87-89%, B = 83-86%, B- = 80-82%, C+ = 77-79%, C = 73-76%, C- = 70-72%, D+ = 67-69%, D = 63-67, D- = 60-62%, and F = 59% and below.
What Kind of Grade to Expect

Grades in any course are a function of 3 factors: the instructor, your natural ability, and your effort. Since you are not the instructor and your natural ability is essentially set, the factor you CAN control is the amount of effort you put into learning. In general, grades are largely a function of student effort. Don't expect to get an A or B simply by coming to class and studying the night before an exam. College courses, particularly this one, demand more individual accountability than high school courses in order to be successful. To help give you some idea on the difference between A and C students, I have included an excerpt from an article written by John Williams. From the characteristics below you can figure out the descriptions for B, D, & F students.

The "A" Student - An Outstanding Student
Attendance: "A" students have virtually perfect attendance. Their commitment to the class resembles that of the teacher.
Preparation: "A" students are prepared for class. They always read their assignment. Their attention to detail is such they occasionally catch the teacher in a mistake.
Curiosity: "A" students show interest in the class and in the subject. They look up or dig out what they don't understand. They often ask interesting questions or make thoughtful comments.
Retention: "A" students have retentive minds. They are able to connect past learning with the present. They bring a background with them to class.
Attitude: "A" students have a winning attitude. They have both the determination and the self-discipline necessary for success. They show initiative. They do things they have not been told to do.
Talent: "A" students have something special. It may be exceptional intelligence and insight. It may be unusual creativity, organizational skills, commitment or a combination thereof. These gifts are evident to the teacher and usually to the other students as well.
Results: "A" students make high grades on tests - usually the highest in the class. Their work is a pleasure to grade.

The C" Student - An Average or Typical Student
Attendance: "C" students miss class frequently. They put other priorities ahead of academic work. In some cases, their health or constant fatigue renders them physically unable to keep up with the demands of high-level performance.
Preparation: "C" students prepare their assignments consistently but in a perfunctory manner. Their work may be sloppy or careless. At times, it is incomplete or late.
Attitude: "C" students are not visibly committed to the class. They participate without enthusiasm. Their body language often expresses boredom.
Talent: "C" students vary enormously in talent. Some have exceptional ability but show undeniable signs of poor self-management or bad attitudes. Others are diligent but simply average in academic ability.
Results: "C" students obtain mediocre or inconsistent results on tests. They have some concept of what is going on but clearly have not mastered the material.
GEOL 106 is an Achievement-Centered Education (ACE) course required for UNL graduation. GEOL 106 specifically addresses the ACE requirements as follows.

Student Learning Outcome 4: Use scientific methods and knowledge of the natural and physical world to address problems through inquiry, interpretation, analysis, and the making of inferences from data, to determine whether conclusions or solutions are reasonable.

The Student Learning Outcome 4 is embedded in this course during class meetings, through homework assignments, and in exams. Lecture topics address the content knowledge that relates observable phenomena with trends, laws, and theories established through use of the scientific method. Students are taught to see phenomena as vehicles for inquiry into the natural world. Assignments further help students learn to interpret, analyze, and make inferences from data. Students experience multiple ways to arrive at the same conclusions and, therefore, experience ways to determine whether conclusions are reasonable. Exams consist of problem-based questions about what was discussed during class meetings and in the assigned reading. Specific questions from any or all of these assessments can be used to assess students’ achievement of Student Learning Outcome 4.

At the end of each academic year, the Earth & Atmospheric Sciences ACE 4 Committee will determine the overall student achievement of Student Learning Outcome 4 by analyzing a reasonable sample of students’ work (examples: in-class activities, homework assignments, and final exams) each semester. Results will be communicated to appropriate ACE committees (individual student results will be kept anonymous).
<table>
<thead>
<tr>
<th>Week</th>
<th>Day</th>
<th>Date</th>
<th>Topic</th>
<th>Reading Assignment</th>
<th>HW</th>
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<td></td>
<td><strong>Part I. Introduction to this course</strong></td>
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<td>7-Jan</td>
<td>What is this class about?</td>
<td>syllabus</td>
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<td>2</td>
<td>9</td>
<td>10-Jan</td>
<td>What is science?</td>
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<td>3</td>
<td>11</td>
<td>19-Jan</td>
<td>How do scientists know what they know?</td>
<td>p. 7-10</td>
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<td></td>
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<td></td>
<td><strong>Part II. How do Earth processes, particularly <strong>natural disasters</strong>, impact people?</strong></td>
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<td>2</td>
<td>4</td>
<td>14-Jan</td>
<td>Volcanoes: Types of volcanoes</td>
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<td>5</td>
<td>16</td>
<td>29-Jan</td>
<td>Volcanoes: How they're studied; Hazards</td>
<td>p. 166-170</td>
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<td>6</td>
<td>18</td>
<td>1-Jan</td>
<td>Volcanoes: How to minimize risk</td>
<td>p. 170-184</td>
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<td>3</td>
<td>21</td>
<td>MLK Jr. Holiday</td>
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<td>23</td>
<td>23-Jan</td>
<td>Earthquakes</td>
<td>p. 185-190, p. 122-126</td>
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<td>Earthquakes</td>
<td>p. 127-132</td>
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<td>9</td>
<td>28-Jan</td>
<td>Driving force behind Volcanoes &amp; Eqs</td>
<td>p.136-144, 146-154</td>
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<td>Jan</td>
<td>Ocean Waves &amp; Tsunamis</td>
<td>p. 98-103, 113-116</td>
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<td>Feb</td>
<td>Ocean Waves &amp; Tsunamis</td>
<td>p. 145-146, 278-280</td>
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<td>4-Feb</td>
<td>Floods</td>
<td>p. 260-264</td>
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<td>6-Feb</td>
<td>Floods</td>
<td>p. 236-245</td>
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<td>Floods</td>
<td>p. 246-254</td>
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<td>15</td>
<td>11-Feb</td>
<td>Hurricanes and Tornadoes</td>
<td>p. 267-277</td>
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<td>13-Feb</td>
<td>Hurricanes and Tornadoes</td>
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<td><strong>Part III. How does the Earth, particularly its natural resources, allow people to live the way we do?</strong></td>
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<td>Rock and Mineral Resources</td>
<td>p. 70, 73-85</td>
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<td>Rock and Mineral Resources</td>
<td>p. 385-388</td>
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<td>Soil Resources</td>
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<td>27</td>
<td>27-Feb</td>
<td>Soil and Forest Resources</td>
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<td>1-Mar</td>
<td>Forest Resources</td>
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<td>4-Mar</td>
<td>Water Resources</td>
<td>p. 326-328, 349-353</td>
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<td>Water Resources</td>
<td>p. 329-338</td>
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<td>Water Resources</td>
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<td>11-Mar</td>
<td>Fossil Fuel Resources</td>
<td>p. 398-405</td>
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<td>Fossil Fuel Resources</td>
<td>p. 408-411</td>
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<td>Fossil Fuel Resources</td>
<td>p. 417-427</td>
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<td>March 18-22 <strong>NO CLASS - Spring Vacation</strong></td>
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<td>30</td>
<td>25-Mar</td>
<td>Non/renewable Resources &amp; Sustainability</td>
<td>p. 401</td>
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<td>31</td>
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<td>27-Mar</td>
<td>Sustainability &amp; Population Growth</td>
<td>p. 22-32</td>
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<td>29-Mar</td>
<td><strong>EXAM 2</strong></td>
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<td><strong>Part IV. How do people cause environmental impacts? How do people impact the environment?</strong></td>
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<td>1-Apr</td>
<td>Mining: Rocks &amp; Minerals</td>
<td>p. 379-385, 389-394</td>
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<td>3</td>
<td>3-Apr</td>
<td>Mining: Water</td>
<td>p. 338-349</td>
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<td>5-Apr</td>
<td>Mining: Fossil Fuels</td>
<td>p. 405-408, 411-417</td>
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<td>36</td>
<td>8-Apr</td>
<td>Pollution</td>
<td>p. 474-482, 493-495, 499-505</td>
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<td>10</td>
<td>10-Apr</td>
<td>Waste Creation &amp; Disposal</td>
<td>p. 482-493, 496-499</td>
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<td>38</td>
<td>12</td>
<td>12-Apr</td>
<td>Deforestation &amp; Soil Erosion</td>
<td>p. 314-322</td>
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<td>15-Apr</td>
<td>Climate Change</td>
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<td>Climate Change</td>
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<td>Climate Change</td>
<td>p. 529-540</td>
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<td>15</td>
<td>42</td>
<td>22-Apr</td>
<td>Is there a problem? Possible Solutions</td>
<td>p. 349-356, p. 428-432</td>
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<td>43</td>
<td>24</td>
<td>24-Apr</td>
<td>Possible Solutions</td>
<td>p. 435-470, 540-544</td>
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<td>44</td>
<td>26</td>
<td>26-Apr</td>
<td>Planet Earth - how unique is it?</td>
<td>p. 43-53</td>
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<tr>
<td>16</td>
<td>30</td>
<td>Tu</td>
<td><strong>FINAL EXAM 1:00-3:00 PM</strong></td>
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</tbody>
</table>
Appendix B

Non/Renewable open-ended question
• We had a range of different ideas expressed in the in-class activities. These were the most popular ideas.

• Right now, I’d like you to think about these choices. Turn to your neighbor and try to come to an agreement about which one of these choices you think is most correct.

• On the count of three, show your vote. 1-2-3

• Okay, before we discuss the most correct answer here, let’s continue to build on this discussion.
Appendix C

Whole-class guided discussion: Plate Tectonics
(5) Plate tectonics whole-class guided discussion and associated exam question

An example of a whole-class guided discussion is partially captured by the sequence of the following four PowerPoint slides (they are animated slides, with sequenced displays of the information):

Theory of plate tectonics continues to be tested.

- We have mapped out the age of seafloor.

*If new oceanic crust is forming at the mid-ocean ridges, why isn’t the Earth expanding?*

What kind of evidence do we have that oceanic crust is subducting?

- Seismic data
Whole-class guided discussions are intended to actively engage students in the acquisition and integration of potentially new information into the framework of their pre-existing knowledge (e.g. Bransford et al., 1997). These four slides capture only a segment of the class discussions had on the theory of plate tectonics, the Earth’s interior, and tectonic plate boundaries.
Appendix D

Lecture Tutorial: Floods and Flood Probability
Flood Frequency & Flood Frequency Curve

Part 1: Constructing a Flood Frequency Curve

A flood frequency curve plots the discharge of a particular stream against how often that discharge occurs. Table 1 below records the levels of floods of Czeckmann River every year from 1950 to 1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>Flood* Discharge</th>
<th>Year</th>
<th>Flood* Discharge</th>
<th>Year</th>
<th>Flood* Discharge</th>
<th>Year</th>
<th>Flood* Discharge</th>
<th>Year</th>
<th>Flood* Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>18, 33</td>
<td>1965</td>
<td>33, 50</td>
<td>1975</td>
<td>18, 50</td>
<td>1985</td>
<td>18</td>
<td>1995</td>
<td></td>
</tr>
<tr>
<td>1956</td>
<td>18</td>
<td>1966</td>
<td>18</td>
<td>1976</td>
<td>100</td>
<td>1986</td>
<td>18</td>
<td>1996</td>
<td>18</td>
</tr>
<tr>
<td>1959</td>
<td>18</td>
<td>1969</td>
<td>1979</td>
<td>1989</td>
<td>33</td>
<td>1999</td>
<td>18, 33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In thousands of cubic feet per second (1000 ft³/ sec); some years have more than one flood.

Table 1. Czeckmann River floods during 1950-1990

(1) According to Table 1, which size flood happens more often? Circle one answer choice: Large / Small

Table 2, below summarizes the number of times each flood happens in 50 years (data used comes from Table 1). The recurrence interval (RI) indicates how often a flood of that size occurs over a specified amount of time. In this example, the specified amount of time is 50 years. So, to calculate the recurrence interval you would use:

RI = 50 years ÷ the number of times that flood occurs in 50 years

<table>
<thead>
<tr>
<th>Flood Discharge (ft³/sec)</th>
<th># of times flood occurs in 50 years</th>
<th>Recurrence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>50,000</td>
<td>6</td>
<td>8.3</td>
</tr>
<tr>
<td>33,000</td>
<td>13</td>
<td>3.8</td>
</tr>
<tr>
<td>18,000</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Summary of Frenchman River flood frequencies

(2) Calculate the recurrence interval for the largest and smallest floods in Table 2. As an example, the mid-sized floods have already been calculated for you.

(3) Referring to Table 2, which you just finished filling in, does a flood with a large recurrence interval occur more or less often? Circle one answer choice: More often / Less often
Figure 1, below, is the flood frequency curve for Czeckmann River. The recurrence interval is plotted compared to the discharge.

![Graph showing flood frequency curve with discharge on the y-axis and recurrence interval on the x-axis.]

Figure 1. Czeckmann River’s flood frequency curve

(4) Large floods that are 75,000 ft$^3$/sec occur on average once every __________ years.

(5) Small floods that are 20,000 ft$^3$/sec occur on average once every __________ years.

(6) Predict the recurrence interval of an extremely large flood with a discharge of 140,000 ft$^3$/sec.

Part 2: Predicting Floods

(1) Figure 1 makes it look like floods of discharge 50,000 ft$^3$/sec occur exactly once every eight years. Look back at Table 1 – Are floods of the same severity (i.e. same discharge) evenly spaced in time? Circle one answer choice: Yes / No

(2) If there is a flood with a discharge of 50,000 ft$^3$/sec, will that flood happen again in exactly eight years? Yes / No Explain your answer in the space provided below.

(3) Say, a certain flood has a recurrence interval of four years. This flood occurred in 2006. What is the percent probability that the flood will happen in 2007?

Percent Probability = \frac{1}{RI}
Appendix E

Interactive Lecture Demonstration: Porosity and Permeability
Rock and Water

(1) Predict what will happen to the water when three drops of water are placed on each of the rocks. Record your predictions in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Prediction for what happens to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>Water will slowly run off of rock</td>
</tr>
<tr>
<td>Basalt</td>
<td>Water will run off rock rather quickly</td>
</tr>
<tr>
<td>Sandstone</td>
<td>Water will flow off rock</td>
</tr>
<tr>
<td>Marble</td>
<td>Water will flow off rock</td>
</tr>
</tbody>
</table>

(2) What actually happened to the water? Record your observations in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Observation for what happened to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>Water settled and slowly ran off rock</td>
</tr>
<tr>
<td>Basalt</td>
<td>Water soaked into the rock and spread</td>
</tr>
<tr>
<td>Sandstone</td>
<td>Water stayed on surface, slowly moved laterally under surface</td>
</tr>
<tr>
<td>Marble</td>
<td>Water stays at surface in droplet</td>
</tr>
</tbody>
</table>

(3) Think about what you observed. Explain why the water did what it did when dropped on the different rocks.

The water would soak in or not soak depending on the surface type and if the rock had air pockets on surface, it would soak in.
Rock and Water

(1) Predict what will happen to the water when three drops of water are placed on each of the rocks. Record your predictions in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Prediction for what happens to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>roll off</td>
</tr>
<tr>
<td>Basalt</td>
<td>roll off &amp; absorb</td>
</tr>
<tr>
<td>Sandstone</td>
<td>absorb</td>
</tr>
<tr>
<td>Marble</td>
<td>roll off</td>
</tr>
</tbody>
</table>

(2) What actually happened to the water? Record your observations in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Observation for what happened to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>slowly started to run off</td>
</tr>
<tr>
<td>Basalt</td>
<td>flows through the rock's air pockets/bubbles</td>
</tr>
<tr>
<td>Sandstone</td>
<td>slowly flows through the rock</td>
</tr>
<tr>
<td>Marble</td>
<td>stayed on top of the rock</td>
</tr>
</tbody>
</table>

(3) Think about what you observed. Explain why the water did what it did when dropped on the different rocks.

The more porous rocks, basalt & sandstone, had space/pores for the water to run through. While the granite & marble are crystallized rocks that do not have those open spaces that allow the water to flow through.
Name: 

Rock and Water

(1) Predict what will happen to the water when three drops of water are placed on each of the rocks. Record your predictions in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Prediction for what happens to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>run over if not absorbed</td>
</tr>
<tr>
<td>Basalt</td>
<td>run down</td>
</tr>
<tr>
<td>Sandstone</td>
<td>will mix with the rock absorbed by the rock</td>
</tr>
<tr>
<td>Marble</td>
<td>run down</td>
</tr>
</tbody>
</table>

(2) What actually happened to the water? Record your observations in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Observation for what happened to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>Run down</td>
</tr>
<tr>
<td>Basalt</td>
<td>work inside the rock through the air holes</td>
</tr>
<tr>
<td>Sandstone</td>
<td>slowly filtering through the rock</td>
</tr>
<tr>
<td>Marble</td>
<td>not mixed with the rock</td>
</tr>
</tbody>
</table>

(3) Think about what you observed. Explain why the water did what it did when dropped on the different rocks.

depends on the crystals in the rock, which make it slower and harder for the water to run into the rock
Rock and Water

(1) Predict what will happen to the water when three drops of water are placed on each of the rocks. Record your predictions in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Prediction for what happens to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>water will run off of the rock</td>
</tr>
<tr>
<td>Basalt</td>
<td>water will be absorbed by the rock</td>
</tr>
<tr>
<td>Sandstone</td>
<td>water will be absorbed by the rock</td>
</tr>
<tr>
<td>Marble</td>
<td>water will sit on top or run off of the rock</td>
</tr>
</tbody>
</table>

(2) What actually happened to the water? Record your observations in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Observation for what happened to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>water slowly ran down the rock but wasn't absorbed</td>
</tr>
<tr>
<td>Basalt</td>
<td>water flows into the rock</td>
</tr>
<tr>
<td>Sandstone</td>
<td>water slowly flows through the rock and away from droplet</td>
</tr>
<tr>
<td>Marble</td>
<td>water droplets sit on top of the rock</td>
</tr>
</tbody>
</table>

(3) Think about what you observed. Explain why the water did what it did when dropped on the different rocks. The rocks with (bigger crystals) do not allow the water to flow through them. 

" tightly locking"
Rock and Water

(1) Predict what will happen to the water when three drops of water are placed on each of the rocks. Record your predictions in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Prediction for what happens to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>water will run off or stay on surface</td>
</tr>
<tr>
<td>Basalt</td>
<td>water will soak into surface</td>
</tr>
<tr>
<td>Sandstone</td>
<td>water will soak into surface</td>
</tr>
<tr>
<td>Marble</td>
<td>water will run off or stay on surface</td>
</tr>
</tbody>
</table>

(2) What actually happened to the water? Record your observations in the table below.

<table>
<thead>
<tr>
<th>Rock Name</th>
<th>Observation for what happened to the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>water pooled briefly then slowly ran down side</td>
</tr>
<tr>
<td>Basalt</td>
<td>water flowed into rock through the pores</td>
</tr>
<tr>
<td>Sandstone</td>
<td>water beaded and bubbled and stayed on surface then slowly moved through the rock</td>
</tr>
<tr>
<td>Marble</td>
<td>water first ran off and the the 2nd time it pooled on the surface and stayed there</td>
</tr>
</tbody>
</table>

(3) Think about what you observed. Explain why the water did what it did when dropped on the different rocks.

The marble and granite were formed by tightly interlocking crystals so the water could not penetrate their surface. The sandstone and basalt allowed water to flow through it because they were porous and had air bubbles and away.
Appendix F

Case Studies: Climate Change Impacts on the Global Community
Small Group Tasks

A. Do a little online research in class to get a broad understanding of your country
   1. 1-3 Key Economic Sectors and/or Geographic Conditions
   2. 1-3 Environmental Concerns
   3. Potential/Actual Government Response(s) by the country

B. Prepare a short 2-5 minute presentation of your findings, for example:
   1. Oral presentation
   2. Short video presentation (i.e., using iMovie or MovieMaker)
   3. Other: run past me first

C. Present to class on Wednesday/Friday
ITALY

(NAMES OMITTED)

ECONOMIC SECTORS

- Predominantly service oriented
  - Not as many job opportunities
  - Many stop schooling at 14 to pick up at trade
- Northern: Well-educated, wealthier
  - Industrially focused
- Southern: low income and unemployment
  - Tourism attracts
  - Vineyards, agriculture
- Main industrial sectors: machinery, motor vehicles, clothing, footwear, and food processing

GEOGRAPHIC CONDITIONS

- Located in southern Europe
- Apennine Mountains form the peninsula’s backbone
- Venice situated on water
- At the meeting place of two plates
- Eurasian plate and African plate

ENVIRONMENTAL CONCERNS

- Long term threats:
  - Floods
  - Worried about priceless artifacts and churches
  - Air pollution
  - Sulfur dioxide
  - Coastal and inland rivers are polluted from industrial and agricultural effluences
  - Inadequate industrial waste treatment and disposal facilities
  - Deforestation
  - Acid Rain
  - Low quality of water
  - Pollution

GOVERNMENT RESPONSES

- Government provides incentives for forest preservation
- Laws and guidelines protecting the seas and coastline
Iceland

Environmental Sectors/Geographic Regions
- many volcanoes and geysers
- glaciers
- warm north atlantic current ensures generally higher annual temperatures than in most places of similar latitude in the world

Environmental Concerns
- glaciers melting
  - they cover 11.5% of region, loss impacts its geology
- sea levels rising
  - condenses population of 300,000
    - hence more urbanization of untouched land
  - loss of islands – Surtsey
    - one of oldest in world, used for research
- change in salinity
- change in ocean temperature and currents

Government Responses to Environmental Issues
Government Responses to Environmental Issues

- only country to use 100% renewable heat & electricity
- glaciers and rivers generate 80% of country's electricity via hydropower
- 90% of homes heated via geothermal water
- geothermal annually saves 646,000 tons of oil, cutting carbon emissions by 40%
- home to first hydrogen fueling station for 85-90% electricity cars and boats, cutting emissions & fuel
- lowered fishing quota by 15%

Works Cited

- http://www.guardian.co.uk/environment/2008/apr/22/renewableenergy.alternativeenergy
**Economic Sectors and Geographic Conditions**

- 80% of the country is involved in agriculture
  - Copra, coconuts, coco, coffee, taro, yams, fruits, vegetables, and beef
- Tourism is Vanuatu’s fastest growing sector
- Recently, large earthquakes have been occurring
- The islands all have volcanic origins and narrow coastal plains
  - Mountainous islands

**Environmental Concerns**

- Water pollution in urban areas is a problem due to inadequate sanitation systems
- Logging industry threatens forests and contributes to the problem of soil erosion
- The reefs on the coasts are threatened by inappropriate fishing methods and siltation
- Estuarine crocodile, hawksbill turtle, Fiji banded iguana, and insular flying fox are threatened species

**Possible Government Responses**

- Improve sanitation system
- Limit the rate of logging
- More regulations on fishing
  - Monitor reef ecosystems
  - Restrictions could be made on the number of fish caught and type of fish
- Monitor endangered species and restore habitats
Appendix G

Short Paper: Trashed – No Place for Waste
“Trashed – No Place for Waste”
Bonus Opportunity

“Trashed – No Place for Waste” is a documentary that will soon be playing at “the Ross.” The subject of the documentary ties into some of the ideas we are currently discussing.

The matinee shows are $6.50 and the evening shows are $7.00 for students (bring your ID).

The documentary will be playing at the Ross from Friday, April 19th, to Thursday, April 25th.

The show times are now posted at: http://www.theross.org/

A Doodle poll has been set up where you can get in touch with classmates interested in attending the same show times that you are available. To use the poll, enter your email address in the space labeled “Your Name.” The Doodle poll can be found at: http://doodle.com/6568y24t28rw8e8c

The location of “the Ross” is at the red balloon labeled “A.”

To earn bonus points through this opportunity, do the following:

(1) Attend the show with at least one classmate.

(2) Each of you take notes on what you each think are the key ideas of the documentary.

(3) After the show, discuss with your classmate(s) the following:
   a) What do you think the key ideas are?
   b) What did you find particularly surprising or interesting?
   c) What questions came to your mind as you watched the documentary?
   d) What you would like to learn more about?
   e) As a group critique the film (include answers to: What were the strengths and weaknesses? Would you recommend this film to other – why or why not?) then, individually, write up your own summary of the group’s critique?

(4) Turn in your ticket stub and a 1-2 page write up (typed or neatly written) that include the following to me by the beginning of class on Friday, April 26th:
   a) The name(s) of the classmate(s) you watched the documentary with
   b) 1-page sheet of the notes that you recorded while you watched the documentary
   b) A summary of the answers you and your classmate(s) came up with in response to the five questions listed above.
The main idea of the entire documentary was primarily focused on the environment through pollution of our land, air, and sea by waste. Jeremy Irons went from country to country looking at the way people live and the risk factors associated with their everyday decisions to dispose of waste. He went all over the world from Lebanon to Britain to Iceland to Vietnam, Wales, Indonesia, Isle of Cumbrae, London, and finally to San Francisco. He looked at the level of dioxins in the atmosphere and how greatly it affected the population of each country. For example, Vietnam children are still suffering from the effects of the Vietnam War. In the Vietnam War, there was a spraying mission in which Vietnam was covered with toxic chemicals. The children today are now born with birth defects because of it. If there were no more dioxins produced in the atmosphere it would still take six generations for the dioxins to completely disappear. In Indonesia, there isn’t a designated place for trash and other waste so the people just throw their trash on the shore and in the sea. The dioxins being released because of this puts the residents living near the beach at high risk. The children are playing in the waste causing an even greater risk of complications later in life. In Iceland, there have been several incinerators placed for waste to better help the environment. But Jeremy Irons says that the chemical emissions being released are becoming too high and still resulting in dioxins being released. We, as a society, are not going to better the environment by burning everything. About 90% of our waste is recyclable and this is said to be a place to start. Working with industries is another place to begin change. We can eliminate the amount of plastic being used for packaging and go green. Jeremy Irons says that we are trashing our planet and that it is time to stop. I couldn’t agree more.

2. Honestly, just about everything in the documentary surprised me. I couldn’t believe how much we have trashed our planet. The effects on the Vietnam children are something that really surprised me. It made me almost sick to watch. These poor children are being born with defects because of something that happened decades ago. The children have no control over it and have to deal with the consequences regardless. Another thing that really surprised me was how Indonesia has no organized waste collection. The people just throw their waste out on the shore and in the sea and think nothing of it. The poor children showed playing in the trash made me so sad. They are getting poisoned with no control over the situation and the sad part is, is that they probably think that those are normal living conditions. And finally, the last major thing that surprised me was all of the information about dioxins. The fact that these dioxins are making killer whales not be able to reproduce really frightens me to think that some day humans might not be able to reproduce either.

3. The one question that kept popping into my mind throughout the documentary was what could I possibly do to help? I will be honest and say that I don’t recycle
but after watching this video, I want to recycle. I don’t want to leave this planet Earth a mess for future generations to live in.

4. I would like to learn more about what I can do to help the environment and waste pollution. Another thing I would love to learn more about is dioxins. I find it really interesting the effects it has on people and the environment. Before watching this documentary, I didn’t even know that they existed.

5. Some strengths of this documentary were motivation for change, inspiring, interesting, and easy to follow. Meghan and I discussed the weaknesses and we really couldn’t come up with any. The only thing we could think of was the very graphic part of the fetuses in Vietnam. But we agreed that the graphic part is the truth and it should be shown. I would definitely recommend this documentary to others. I think that it was very interesting and informational. I was surprised walking out how much I really enjoyed it. But I have to admit, this documentary got me thinking and made me want to go out and change the way I live.

*I went with
There were several key ideas in this documentary. Stefanie and I identified that the key ideas could best be described as main concerns associated with waste around the world. The first major concern is that there are no 7 billion people creating waste. There are such large amounts of waste and no completely risk free way to deal with it. There is infinite growth over finite resources, and that is becoming a major issue. The issues with landfills are that they never seem to contain the waste completely. Trash always seems to penetrate through the sanitary liners in landfills and a liquid created from the waste percolates into the ground. Another issue with landfills is that they always end up seeping through the clay cap and contaminating the air. Landfills are not being regulated as well as they should be and hazardous waste is ruining soil and affecting the health of people nearby waste sites. These landfills can increase cancer, birth defects and affect the immune system. Unfortunately not much is being done to prevent this. Waste companies argue that there is not enough conclusive results of negative effects on human health to deem their landfills as hazardous.

The next key idea was the issue with incinerators. While the idea of burning trash looks like a good idea on paper, it can actually be more damaging than landfills. The fume of toxic chemicals created by the burning of waste contains extremely dangerous fumes that are being breathed in by humans and animals. While there is several different toxic chemicals produced from incinerators the worst is Dioxin. Dioxin can cause cancer, horrific birth defects, it damages the
immune system, it can affect fertility, it can reach our brains, liver, and blood. Not only does this affect humans but it is also found in animals. Every human on earth today has dioxin in his or her system. Children that will be born will also have dioxin in their system transferred in utero.

The last key point was the issue of plastics and waste containing the oceans. Marine animals are found with plastic and other types of waste in their stomachs. Oceans are becoming plastic soups. There can be more plastic fragments found in ocean water than zoe plankton. This is a huge problem. The best way to fix all of these issues is to cut down on use. Reusable materials are the only way to go and everything must be recycled in order to start improving these major hazards of waste.

I found it fascinating that a woman who was interviewed was able to only produce one plastic shopping bag worth of waste for an entire year from a family of 4. That shocked me as well as giving me great inspiration to cut down on my personal waste. I found myself wondering how can we make recycling and cutting down on waste simpler and more doable so more people will be on board. The more convenient it is the more people will do it. I would like to learn more about economic factors of recycling and how it can actually improve our economies.

This film was very motivational for change. It left you feeling inspired to change your current lifestyle. It was very interesting and helped my attention the entire time. It was also easy to follow. Stefanie and I could not think of any weaknesses about this documentary. It was very well done. I would recommend for anyone to see this documentary, in fact I think everyone needs to see it.
Key Ideas: How does this trash effect us? We are seeing effects of waste on climate. Incineration is still toxic and not well regulated. We are killing ourselves through our waste. We have the ability to divert waste from landfills to better alternatives and we have the ability to reduce our waste.

Interesting points: 80 tons/day of waste is produced in Lebanon. Their landfill is 40m tall. They were given a donation of $5 million to clean up the dump but there are no visible results. In the UK 80% of people live within 2km of a tip (landfill). Landfill companys control many of the scientists who provide the studies through the money they give them. In New York state alone there are 14 landfills that are filled to capacity. With sanitary and containment landfills the barriers will eventually fail which means they will still be effecting the environment hundreds of years from now. Japan alone has 469 incinerators. Even low doses of dioxin are toxic. The arctic is one of the most toxic places on Earth because the toxins are condensed due to the cold weather. There are not any oceans on Earth that are free of plastics. In water, plastics latch on to other chemicals such as fertilizer and herbicides. It was also interesting to see the use of digestors as a way to decompose organic waste. The final interesting point is that the young couples of today are most affected with pregnancy rate due to the prior transfer of chemicals from their mothers.

Questions: If we know incinerators are unhealthy why do we still push for their use as though they are good for us? How do we reverse what we have done since dioxin does not biodegrade?

Want to learn: Since dioxin is stored in fatty tissue, what happens when a person loses fatty tissue through weight loss?

Film critique: This film had a good global perspective by interviewing people from all across the globe. Another strong point about the movie was that it used emotion very strongly but interjected some bits of humor so it didn't completely devastate you. There were also lots of facts and solutions for the
greater community scale. A weak point that we found was that it could have specifically addressed more ways an individual could make changes. We discussed that it briefly touched on a few points but since it is marketed to the general public it could have had an extra 20 minutes added to the film to “solve” individual action.

Our group had many of the points in common from this video. Our discussion afterward led us to talk a lot about our local campus action and things that could be done. David and I discussed how the University could send its food waste from the dining halls to be composted on East Campus for public use. I also mentioned that the dining halls on campus are performing a study to determine how much waste is produced and placing a goal of zero waste through the cooking process. Jessica mentioned that the research departments could improve their water systems by implementing a water recycling program.