Adapting InTeGrate for the Large Lecture Classroom: Impacts on Engagement and Student Performance

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Abstract

The InTeGrate project seeks to incorporate concepts of sustainability and societal issues into the geoscience classroom using inquiry-based, active-learning approaches. A multi-institution study is documenting the changes in student performance and attitudes as a result of replacing approximately one-half of existing course materials with InTeGrate modules and units. This presentation focuses on the changes in practice and impacts on student success as a result of implementation of InTeGrate materials in an undergraduate physical geology course at the University of West Georgia. This course fulfills a science requirement for all UWG undergraduates, and the student population is largely non-science majors. Several types of data were collected to assess student engagement (attendance, homework completion, attitudinal surveys) and student performance (including GLE summative assessments and other class-based pre-/post-tests) across control and treatment groups. The control semester (Fall 2015) was taught using traditional course materials and approaches; during the treatment semester (Fall 2016), the class was significantly revised by replacing existing content with InTeGrate materials, including two complete modules (Human Dependence on Earth's Mineral Resources, Living on the Edge) and selected units from several other InTeGrate modules (Environmental Justice and Freshwater Resources, A Growing Concern, Natural Hazards and Risks: Hurricanes). Several adaptations were made to InTeGrate materials and activities to make them more user-friendly and effective for the large lecture hall setting; specific examples will be discussed in the context of overcoming challenges related to logistical or student success issues.

Classroom Setting

GEOL 1121 (Introduction to Physical Geology) is a 3-hour lecture course commonly taken by non-STEM majors to fulfill science requirements, and is majority freshmen. There is a standalone lab course (GEOL 1121L) that most students take concurrently, but it is not required.

The section of the course that is the focus of this study is taught in a traditional 115-seat lecture hall, with rows of fixed tabletops in a shallow stadium bowl and a central aisle. There is a fixed projection screen and a portable whiteboard at the front of the classroom. One or two undergraduate student assistants are hired by the department to assist with classroom management and attendance.

Students are expected to purchase a textbook, and a course packet has also been offered to the students to organize their notes. Assignments are regularly posted to the online CMS, including auto-graded quizzes and open discussions.

Why InTeGrate?

▶ To increase scientific literacy

▶ To promote critical thinking skills

▶ To make the classroom learning environment more active and student-centered

▶ To emphasize the importance of sustainable management of mineral, water, energy, soil and land resources

The Transformation

Fall 2015 (Control) Lecture Topics Converted:

- Earth Materials: Minerals
- Igneous Rocks & Processes
- Sedimentary Rocks & Processes
- Metamorphic Rocks & Processes

→ **Fall 2016 (InTeGrate) Modules Presented:**

Humans' Dependence on Earth's Mineral Resources (full)

- The Hydrologic Cycle
- Rivers and Streamflow
- Groundwater

→

Environmental Justice and Freshwater Resources (part)

- Weathering and Soils

→

A Growing Concern: Sustaining Soil Resources through Local Decision Making (part)

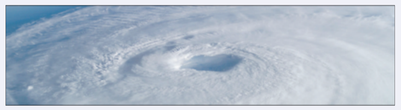
- Plate Tectonics
- Earthquakes
- Volcanoes and Volcanic Hazards
- The Ocean Floor
- Crustal Deformation and Mountain Building

→

Living on the Edge: Building Resilient Societies on Active Plate Margins (full)

- Shorelines

→

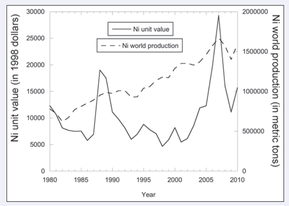


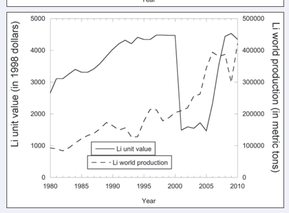
Natural Hazards and Risks: Hurricanes (part)

InTeGrate content replaced approximately one-half of the original course content in Fall 2016. The new materials were piloted in Spring 2016, in a smaller (65-seat) lecture section; some modifications to the materials (content, sequence, delivery style) were made based on student feedback and instructor experiences.

Implementation and Results

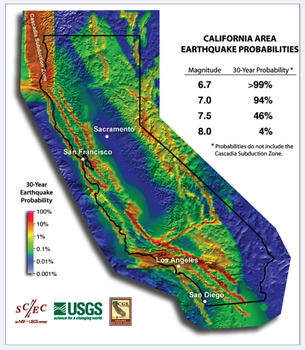
The InTeGrate materials provide students with the opportunity to conduct data-rich, active-learning investigations within the classroom. The application of geologic principles to "real-life" scenarios emphasizes the importance of geologic knowledge to society, and the importance of developing sustainable practices. Some examples of activities used in class:





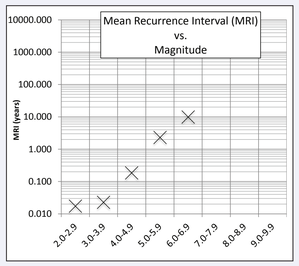
Humans' Dependence on Earth's Mineral Resources:

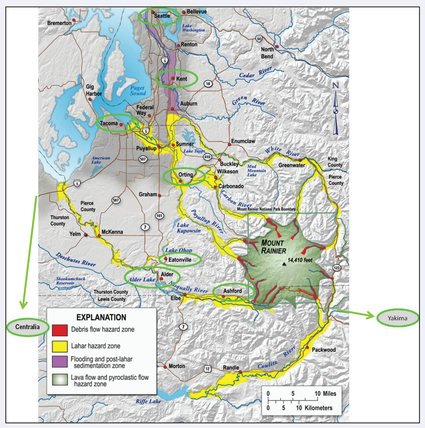
Students are asked to evaluate the impacts of real-world events (mines opening/closing, changes in regulatory environment, development of new technology) on supply/demand and costs for products made from mined resources.



Living on the Edge: Building Resilient Societies on Active Plate Margins:

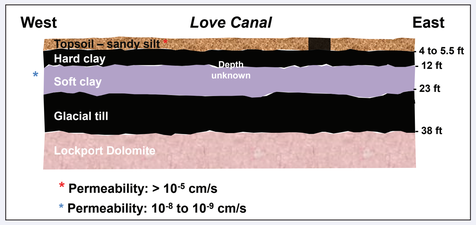
Students use and extrapolate from real data to calculate the probability of a large-magnitude earthquake striking Los Angeles or San Francisco in the next 30 years. Data is used to discuss the nature of earthquake hazards, risk management, and mitigation along transform plate boundaries.





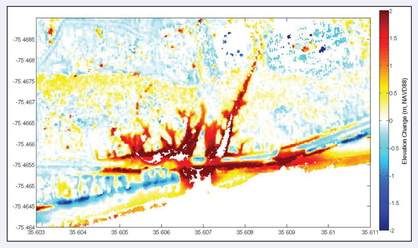
Living on the Edge: Building Resilient Societies on Active Plate Margins:

Students monitor and interpret tilt, gas emission, and seismic data sets for a potentially-active Cascade volcano in order to assess risk levels and potential geologic hazards for residents and infrastructure in surrounding communities.



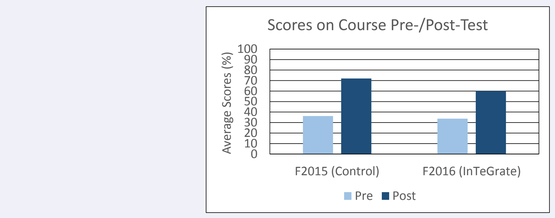
Environmental Justice and Freshwater Resources:

Students learn about the history of the Love Canal site, apply concepts of hydrogeology to understand the flow of contaminants into the neighborhood around the dump site, and discuss the importance of scientific literacy on human health.

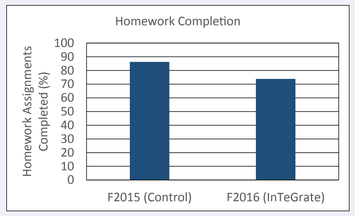


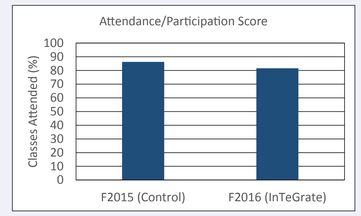
Natural Hazards and Risks: Hurricanes

Students examine aerial photo and LIDAR data to observe patterns of erosion and deposition and shoreline changes along the Outer Banks due to the landfall of Hurricane Irene in 2011. This exercise is used to lead in to a discussion of barrier island stability and risks associated with continued changes in sea-level.



Students completed a 25-question quiz (previously developed for departmental use) at the beginning and end of each semester. The learning gains shown on the course post-test were stronger for the Fall 2015 (Control) cohort; this reflects changes in alignment of the course goals with the implementation of InTeGrate materials (some material on pre-/post-test is no longer directly covered as part of the revised course).





Student engagement in the materials was tracked using both homework completion (left) and attendance/participation (right). The InTeGrate implementation requires a partial flipped-classroom approach, which increases student workload outside the class meetings. Students who are unable or unwilling to complete pre-class or post-class assignments will be at a disadvantage to their peers in the classroom.

Adapting InTeGrate for Large-Lecture Courses

Many modules and activities were designed and optimized for classes of 20-30 students. Based on lessons learned and student feedback across Pilot and Implementation semesters, here are some suggested strategies for addressing the challenges that may be associated with assimilating InTeGrate content into your large-lecture classroom:

Challenge:
▶ Large volume of grading (pre-/post-activity assignments), no graduate TAs

Solution:
▶ Convert assignments to auto-graded quizzes administered in course LMS

Challenge:
▶ Swamped by time-consuming paperwork (handouts, hand-ins)

Solutions:
▶ Limit hand-ins required for grading by using Clicker quizzes / polling software
▶ Incorporate handouts into a Course Packet for student use in classroom

Challenge:
▶ Lack of access to computer/software (financial need, classroom constraints)

Solution:
▶ Laptop / internet-based activities in classroom are optional, also provide "static" versions
▶ Can demonstrate "live" versions in classroom

Challenge:
▶ Students lack geographical familiarity or are intimidated by math

Solution:
▶ Encourage students to work together to problem solve!

Challenge:
▶ Significant change of focus from other sections / textbook coverage

Solutions:
▶ Use a Course Packet to integrate old course content and new
▶ Consider which concepts you need to teach, what you want students to know

Challenge:
▶ (Some) students skeptical of content that isn't strictly "geology"

Solution:
▶ Let students work with the data, and enjoy the robust class discussions that follow!

Acknowledgements

The author thanks the other members and leadership of the InTeGrate Research Team for the productive discussions and support throughout the implementation process; and to SERC for logistical support and organization of data collection and processing.

Collection of student data was in accordance with UWG IRB approval # 16_0101.

InTeGrate materials may be accessed at: https://serc.carleton.edu/integrate/index.html