TAPPING OUR STUDENTS' CREATIVITY TO LEARN EARTH AND PLANETARY SCIENCE. R. E. Beiersdorfer, Department of Geology, Youngstown State University, Youngstown, Ohio, 44555, ray@cc.ysu.edu

Introduction: Teaching and learning strategies based on engaging a student's creativity allow them to have fun as they learn science. I believe that every student in my class is a unique, wonderful human being with unlimited potential. Unfortunately, too many of them are limiting their potential by anxieties about science and have signed up for introductory geology or planetary science as an "easier" way to fulfill the general education science requirement. Overwhelming these students by lecturing about a great deal of geology or planetary science content reinforces their perceptions that science is hard and that it is done by "other" people. In order to help the students make connections, I create a class environment where they can combine the subject matter of geology or planetary science with their creative spirits. This is accomplished by a series of group projects related to various geology or planetary science topics (e.g. meteorites, rocks, minerals, astrobiology, earthquakes, volcanoes, etc.). The projects are designed to enable students to learn the course content while they are synthesizing and applying the subject matter in creative ways. By using an experiential approach the students have fun as they learn about the grandeur of the solar system and humanity's place in it.

Project-Based Teaching and Learning Strategies The students form groups of four during the first week of class and work collaboratively on their projects. Each group does three projects that are spread out over the term. Everyone in the class does the same projects and presents their results at the same time. The projects are part of a many faceted assessment plan that includes attendance, class participation, internet-based homework, group quizzes, writing of exam questions, and traditional midterm and final exams. The projects are all valued the same as the midterm and the final examinations. Each is worth ten percent of the student's total grade. I consider these projects alternative assessments to traditional exams but I hope they go beyond that. One of my major goals in this project-based approach is to enhance learning for students whose dominant learning style is not consistent with a traditional lecture-based approach [1].

I have had the students do as few as one and as many as five projects per term. Based on four years of classroom experience I have determined that three projects per term is the optimal amount. Listed below are brief descriptions of projects I am currently using or have used in the past.

Meteorites The Madison Ave. Project The students develop an advertising campaign, including a commercial to seel a type of meteorite to the public. The ad campaign and commercial are presented in class.

Astrobiology The Broadway Project The students write and perform as short play about extraterrestrial life.

Planetary Motion The Baryshnikov Project The students will use dance to illustrate their understanding of planetary motion.

Minerals The Scavenger Hunt The students go on a scavenger hunt to find 20 items that have minerals in them. For example, the mineral calcite is one of the main ingredients in toothpaste.

The Rock Cycle The Geology Rocks Project The students create a rock and roll song about some aspect of rocks or the rock cycle. The songs are performed live on stage in the coffee house in the student union building. Prior to the performance we produce a program containing artwork and the lyrics to all the songs. By following along with the lyrics, the non-performers learn by observing the creative ways their classmates incorporated the class content into song.

Erosion The Dr. Seuss Project The students will compose a children's book, complete with illustrations, about Mass Wasting, Streams, Glaciers, Wind Erosion, or Wave Action. The books are read aloud as the illustrations are projected for viewing.

Environmental Geology The Judy Chicago Dinner Party Project The last class of the term in my Environmental Geology class includes a dinner party. Each group designs the table settings for their table around an environmental topic and brings in a food item (potluck style) that is related to that same topic.

Planetary Geology The TV Game Show Project These projects are spread out over the course of the term. Each group picks a planet or moon and creates a game show for the rest of the class to play. We use this as a way to review each planet we have just covered. Most TV game show projects are modeled after current popular shows such as Who Wants to be a Millionaire?, Hollywood Squares, or Jeopardy.

Volcanoes & Intrusive Rocks The Bill Gates Project The students create a web site about volcanoes and/or intrusive rocks.

Sedimentary Rocks The Hemmingway Project The students compose a work of fiction depicting the life cycle of a grain of sediment in a sedimentary rock. It will start life in a rock and have a long and varied history until its present day location inside another rock.

Metamorphism The Longfellow Project The students use the process of rock metamorphism as a metaphor to compose a poem about change (as in rock undergoing metamorphism from one type of rock to another).

Geologic Time The Clive Cussler Project The students compose a work of fiction where a Dirk Pitt style hero goes back to some period in geologic time to solve a mystery.

Radiometric Dating The People's Court Project The students put the radiometric dating technique of determining the age of the Earth on trial. Different groups serve as prosecuting and defense teams, judges and jurors.

Geologic Structures The Salvador Dali Project The students create a work of abstract art illustrating the key points about the deformation of rocks. The students produce an art show of this work.

Earthquakes The Broadway Project The students compose and act out a skit depicting living through or dying in an Earthquake that they have fabricated. As part of this project the students create a "Playbill" which features a newspaper account of the fictitious seismic event.

Application in the Classroom: Other than laying out the guidelines for the project and offering advise in terms of the quality and quantity of class content in their projects, most students require very little guidance or coaching to successfully complete their projects. The guidelines are explicit in describing what the students are expected to do. For example, the guidelines for the Geology Rocks project are: Your group will create a rock and roll song (or rap, swing, be-bop, country, opera or whatever) about some aspect of rocks or the rock cycle. The song will be performed live in class, music (live or recorded) is required. The music cannot have conflicting pre-recorded lyrics. You will need to find an instrumental version of the song to sing over. You will turn-in (in advance via the class website) the lyric sheet. If you choose to, you can create album cover artwork, but this is optional. Each group's lyrics and artwork will be compiled into a program of our "rock concert."

The creative arts are an important part of many people's lives and most students seem to naturally take to these assignments. The musicians and artists in the class suddenly find themselves in a leadership role in a subject far removed from their area of expertise. In the weeks prior to the presentations or performances, I share, during class, material to allow the students to get a better understanding of what is expected and what works well. For example, I play professional recordings of geologic interest (e.g. Volcano by Jimmy Buffet and Hot Lava by the B52's) as well as videotapes of students in previous classes performing their songs. I also share examples of children's books created by other students for their Dr. Seuss project. I continually stress that I am not interested in how well they sing or draw. I am just interested in how well they can use song or illustrations to demonstrate their understanding of geology or planetary science. The assessment of each project is done on a "acceptable/unacceptable" basis and covers both content of the material and quality of the performance. In the rare cases where the students submit an unacceptable product they are given the opportunity to try it again.

Significance: The significance of this approach is several-fold. People with science-phobias lose some of their fear of science. Making learning a fun experience invigorates the life-long learner inside every student. These projects require the students to apply, arrange, assemble, choose, collect, compose, construct, create, demonstrate, design, develop, dramatize, illustrate, interpret, manage, operate, organize, plan, prepare, sketch, use, and write. These are all activities that fall under the higher order thinking skills of application and synthesis according to Bloom's Taxonomy [2]. In addition, this approach utilizes several of the American Association for Higher Education's nine principles of good practice for assessing student learning [3]. For example, this approach: 1) employs a diverse array of methods, including actual performance, 2) treats learning as multidimensional and integrated; 3) requires attention to outcomes but also and equally to the experiences that lead to those outcomes; and 4) involves not only knowledge but attitudes, and habits of mind that affect both academic success and performance beyond the classroom. Finally, the course content assessed includes the nature of the Earth or other planets and the processes that shape them. An understanding of both of these topics is considered essential to a scientifically literate citizenry [4].

References: [1] Grasha, A. F. (1996) *Teaching with style: a practical guide to enhancing learning by understanding teaching and learning styles*, [2] Bloom, B. S., ed., 1956, *Taxonomy of educational objectives: The classification of educational goals, Handbook 1: The cognitive domain*, [3] AAHE Assessment Forum, 1997, *Learning Through Assessment: A Resource Guide for Higher Education*, L. F. Gardiner, C. Anderson, and B.L. Cambridge, eds., [4] Rutherford, F. J., 1990, *Science for all Americans, American Association for the Advancement of Science, Project 2061*