Essays by Affective Domain Workshop Participants

ALAN BOYLE, DEPARTMENT OF EARTH & OCEAN SCIENCES, UNIVERSITY OF LIVERPOOL
ESSAY: TEACHING THROUGH GROUP WORK

Many years ago, I taught a second year metamorphic petrology course comprising 12 lectures and 6 three hour practical sessions. Each of the ~40 students had to complete a synthetic map and sample based problem by the end of the six practical sessions. Because they were all working on the same problem, but supposedly producing independent work, I had to stop them from talking to each other.

After two years of doing this, and marking a large number of very similar project reports with no time to feedback to the students, I changed. I split the class into groups of 5 students, so that I had ~8 groups working on the project. I redesigned the project so that parts of it could be split up and allocated within groups (data collection), but parts required them to get together on a regular basis to check things were consistent (synthesis/evaluation). I wanted them to talk to each other within groups, but encouraged the groups to be independent. The practical sessions became much more manageable. I could talk to groups about their progress, and it was easier to get around 8 groups than 40 individuals. The groups became naturally protective of their own intellectual copyright. I didn't have to be a policeman, I could be a friend. The atmosphere changed from a closed one to more open collaborative one. The standard of work improved, with reports being more thorough, partly because the groups had more time (5 students' time rather than one). I spent much less time marking, and so could afford time to discuss the assessment outcomes of the project reports with each group in a meeting where they could talk their group mark up or down. Students within groups also have to agree how to divide the marks; who did the valuable work? Most students liked this approach, though there were some who would have preferred to work alone and stated vehemently so in feedback. Some students, due to peer pressure from within the group, did more work in the group than they may have done alone. There were also the occasional disasters where a group member disappears along with data at a crucial time. However, helping groups contend with such disasters and work out strategies to get around the current one and avoid them in future resulted in interesting communication. I felt much better after the change (and ever since) because I had less marking to do and I could engage better with the students. Overall it has been a win-win situation – better for the students and for me. I have used group-based projects in other parts of my teaching and would like to understand more about the psychology behind group dynamics and effects in the affective domain rather than my current anecdotal understanding. How can the effects be quantified? I have done some affective domain work quantifying individual perceptions of the effect of field work (Boyle et al. in press in Journal of Geographical Education) through the use of pre- and post-field-class questionnaires, but would like to understand the effects of group work.

LEWIS BROWN, GEOLOGY/PHYSICS, LAKE SUPERIOR STATE UNIVERSITY
ESSAY: MODELING CONSTRUCTIVISM IN INTRODUCTORY GEOLOGY COURSES

Pre-service elementary teachers commonly postpone taking required science courses because of a lack of confidence in their science abilities. These students commonly express doubts about their ability to learn or understand science concepts and hesitate to plan or engage in activity-based learning activities because of this lack of self confidence. They are much more confident in developing science lessons that are teacher dominated, textbook based, and centered solely on basic knowledge acquisition.

Additionally, pre-service teachers are often taught the concepts of constructivism by lecture rather than experientially, thus immediately defeating the purpose and intent of active learning strategies. In modeling the way they have been taught, these pre-teachers reject active learning and K-6 science remains a traditional, memorization-based, intellectually stultifying discipline.

To encourage adoption of activity-based learning strategies that might emphasize and value independence of learning, self confident problem solving, creativity, inquisitiveness, etc., it is necessary to develop and implement appropriate learning situations in which pre-service teachers gain both experience and self-confidence. I have personally attempted to do this in both field courses (Brown and others, 2001) and introductory geology courses. Use of variously structured group-based projects, discussions, debates, concept mapping, and problem solving laboratory activities that I have incorporated into my introductory courses (Kelso and Brown, 2004) are attempts at structuring a relatively active learning environment to promote student self confidence, inquisitiveness, etc. In this way I attempt to model the teaching methodology that many science educators have advocated for generations with the hope that students in my classes will come to appreciate the excitement of science, will develop positive attitudes and lose their fears of science, and will perhaps cast themselves into the position of pursuing scientific careers. A further goal is encouraging pre-service teachers to adopt and implement similar teaching methodologies in their future classrooms.

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ROBERT BUTLER, PHYSICS, UNIVERSITY OF PORTLAND

ESSAY: UNDERSTANDING THE POWER OF PLACE IN GEOSCIENCE EDUCATION

In my teaching of introductory Geoscience courses and projects in Earth Science teacher professional development, I have been fortunate to work with three masters of Geoscience Education who helped me understand the "power of place". While at the University of Arizona, I worked extensively with Peter Kresan, who is both an extraordinary Geoscience educator and a professional photographer. Peter showed me the power of landscape photography in stimulating students' interest in Geoscience and the importance of place in explaining the relevance of Geoscience to students' lives. With his guidance and in collaboration with desert ecologist Tony Burgess, I developed a field-based course called "A Sense of Place" that provided an introduction to the natural history of Tucson and surrounding mountain ranges for nonscience majors at the University of Arizona and K-12 teachers of Earth Science (Butler et al. 2000). In the process of building a field-based teacher professional development program in the Pacific Northwest, I have collaborated with Ellen Morris Bishop, a geologist and award-winning photographer and writer who teaches Earth Science through inquiry, art, and observation (Bishop 2003, 2004). Charles R. (Kip) Ault, Jr. is an expert on Science Education with publications on children's perception of geological time and the role of scale in geological problem solving (Ault 1982, 1998; Orion and Ault 2006). Kip provided me a general way to understand the importance of the affective domain through his guiding principle that successful science learning opportunities must be "inviting, accessible, and useful" to the learner. I have come to understand that anchoring students' learning to local and regional landscapes greatly enhances their learning of and appreciation for Geoscience. Connection to place is emotional and can be engaged to make Geoscience both inviting and useful for students.

Every semester I teach an Earth System Science course that is required for students in the School of Education at the University of Portland. Most of these students are female, often describe themselves as "not good at science", and are generally apprehensive about taking science courses. I have invested large amounts of time "Oregonizing" Earth System Science by developing examples of how fundamental Earth Systems concepts (e.g. atmospheric circulation patterns) can explain familiar aspects of the Pacific Northwest landscape (e.g. high rainfall west of the Cascades and dry regions east of the mountains). This place-based approach helps make Earth Systems concepts accessible to learners who are familiar with local and regional landscapes but have not previously sought to understand those landscapes as the result of Earth processes.

Over the past three years, I developed a course in Natural Hazards of the Pacific Northwest that is popular with nonscience majors. In some sense, this is an easy sell because our active continental margin setting presents many geologic hazards. However, I have found that students' connection to place can be both an invitation to study natural hazards (How do we know that a great earthquake occurred on the Cascadia subduction zone in January of 1700?) and an impediment to learning about specific natural hazards (What do you mean my home town is built on an ancient lahar from Mt Rainier?). Understanding the affective domain is important both to engage interest in student learning about natural hazards and to avoid triggering negative emotional reactions that can block such learning. My appreciation for the importance of the affective domain has been increased by two recent publications by Zull (2002) and Bain (2004) in which the importance of the affective domain is often addressed and analyzed.

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ANN BYKERK-KAUFFMAN, GEOLOGICAL AND ENVIRONMENTAL SCIENCES, CALIFORNIA STATE UNIVERSITY - CHICO

ESSAY: TEACHING EVOLUTION IN AN INTRODUCTORY GEOLOGY COURSE

Over my 17-year teaching career, I have taught Introductory Geology for non-science majors many times. Until recently, I had always avoided the topic of evolution. But I kept feeling like I was shirking my responsibility to give students the general education they needed, especially after my father told me that he always taught evolution in his introductory Psychology classes. So, three semesters ago, I put "The Theory of Evolution" on the syllabus.

I thought I had a clever way to deal with the topic and proceeded to build the lecture that way. My gimmick was this: I admitted that "If there is an all-powerful supreme being, s/he can do whatever s/he wants and scientists can never disprove it." I said that it was perfectly possible that some supernatural being had really created the universe in one week, 6000 years ago, but that s/he created it with a huge built-in body of amazingly consistent evidence for a very specific and very ancient history. And so s/he must have, for some reason, wanted us to discover and interpret that evidence and to reconstruct that ancient history. I then talked a bit about the scientific method and stated that biological evolution is the only scientifically valid theory for the origin of species. I quoted Phillip Johnson's (1991) book that launched the "Intelligent Design" movement, "This isn't really, and never has been, a debate about science. It's about religion and philosophy."

With this (I thought) clever and disarming preamble, I proceeded to describe Darwin's theory of natural selection, using material from the excellent "Understanding Evolution" web site at UC Berkeley. I presented a bit of evidence, stated that there are mountains more of it, and went over some common misconceptions. I delivered this lecture with some humor, illustrating it with cartoons. I thought I did a great job and so I presented the lecture much the same way the next semester.

But then I noticed that, on the course evaluations, a number of students specifically mentioned this lecture. They complained that it was "sarcastic," and in bad taste. Their perception was that I was making fun of them. Some said I shouldn't be teaching this material at all. I was stunned.

The next semester, with some trepidation, I put the topic of evolution on the syllabus again. I had no idea what I would do differently this time. But then, just a week before the lecture, I attended an excellent GSA talk by Barry Bickmore entitled Science as "storytelling" for teaching the nature of science to preservice teachers (Bickmore and others, 2006). I based the preamble to my lecture on Barry's talk and the essay he graciously provided (Bickmore and Grandy, 2006) which presented seven "rules for scientific storytelling," including the rule that "scientific explanations do not appeal to the supernatural" and why scientists follow this rule even when they themselves believe in the supernatural. After describing these rules, I again presented the material from the UC Berkeley web site. This time, students were able to take in the material. Several specifically told me how much they enjoyed the lecture. The theory of evolution finally made sense to them.

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TAIT CHIRENJE, ENVIRONMENTAL STUDIES, RICHARD STOCKTON COLLEGE OF NEW JERSEY
ESSAY: ISSUE BRIEF ON THE ENVIRONMENT

In my Environmental Issues class (sophomore level) I have a section where I try to cultivate student political involvement by assigning an Issue Brief on an environmental issue that concerns (or gets to) them and submit it to the school paper and/or a local paper for publication. This activity entails students researching an environmental issue and writing a two page brief in which they discuss the origin of the problem, its impacts, and propose solutions. This exercise prepares them to present their thoughts and arguments in a concise manner and to convey information in different forms of media to different people, including politicians at the local, state and federal levels. They are supposed to work on up to three briefs a semester although only one will be selected for submission.

The second part entails presentations of their favorite brief and defending their opinions in class. This is the part where the affective domain dominates. Oftentimes our debate boils down to whether we have more power if we work on an individual level (individualization) or we try to group together with "like" minded people to bring about far reaching changes on a broader scale. The class is then polled on an issue (e.g. pay as you throw system for garbage collection as a means to reduce waste generation) and students are assigned groups with people who do not share the same viewpoints and asked to reach a consensus. The class has a cap of 20 students, so we usually end up with four groups of five. The resulting chaos is what led me to sit in a Moral Theories class because I just could not navigate the complex landscape that we weave by creating these teams.

The topic I have consistently had success with is "Should families with more than two children pay more local taxes since two thirds of our taxes go towards schools?". I often get one group member who ends up writing a dissenting paper even after the group has reached "consensus" (they are allowed to do this). This brings out other questions on what we should do with individuals who may have very valid concerns about something in the society but who are, unfortunately, always outvoted.

I like this exercise because students are able to see why seemingly simple problems take a very long time to solve in municipal governments and also why we have provisions to protect the interests of minority groups, racial, ethnic or otherwise. It also makes it easier for me to extrapolate concepts on special provisions needed for consensus building in state and federal bills (e.g. earmarks) and international treaties or laws (e.g. different targets for developed and developing nations in the Montreal Protocol).

MIRIAM FUHRMAN, ASSESSMENT DIVISION, AMERICAN INSTITUTES FOR RESEARCH

ESSAY: WHY WOULD I WANT TO WORK IN THE DIRT WITH ROCKS?

The last few years I have been involved in a project for which we have developed a conceptual framework for recruitment and retention in the geoscience career "pipeline". This framework includes a set of factors that appear to affect an individual's attitude toward entering or leaving the pipeline. A pilot critical incident study we have carried out (Fuhrman et al., 2004) has identified several such factors that are specific to the geosciences. These include indicators such as past outdoor experiences and familial characteristics. Based on this framework, we assist OEDG grantees in the evaluation of the effectiveness of their programs in encouraging members of underrepresented minorities to enter and remain in the geoscience career pipeline. The instruments used typically include items that assess students' attitudes toward geoscience: fiscal expectations, interest, perception of difficulty, perception of "fun", and support of family and friends. Some items address whether students have prior experience in the outdoors, but one set of factors that we tend not to emphasize in either surveys or interviews is the students' perceptions of physical safety and comfort associated with learning in the geosciences. These factors do sometimes appear when open-ended items are used that ask "What did you like LEAST about the program?" or when students are asked to journal their experiences in a field-based program.

In the last few years, I have had many conversations with geoscientists and people who at some point were in the geoscience pipeline but are no longer. I am convinced that the issue of physical comfort is very important in an individual's attitude toward geoscience as a future profession or even as a course to take. Drawing on anecdotes from these conversations and my own experiences as someone who wasn't really interested in terrestrial geology until after realizing during college that planetary geologists have to first learn on planet Earth, I have developed a list of "physical comfort" issues that I think concern students when they find out that they are expected to do "field-work" in a course. How the students deal with these issues and conditions will have a strong affect on how they feel about taking field-based geoscience courses and considering pursuing the geosciences as a career:

- Personal hygiene issues: Will I be able to take care of my private needs privately?
- Fitness issues: Am I physically strong and fit enough?
- Personal safety issues: How dangerous is it? Are there dangerous insects/animals/trails?
- Comfort issues: Will I get hot/cold, wet, dirty?
- Related "prestige" issues: Do I want to pursue a profession that requires discomfort and exposure to dirt and the elements??

For members of certain groups, cultural or social/economic class concerns dealing with these issues may cause potential students (and their families and friends) to ask "Why would I want to study/pursue a field of study that means I have to get uncomfortable and dirty in order to do it? Field-work is for the lower economic classes -- my ancestors worked hard to leave that all behind…why should I go backwards?"

An extension of our pilot critical incident study and subsequent survey items can assess the significance of these issues -- it is important to included as interviewees people who had the opportunity to enter or stay in the pipeline but have left at a relatively early stage -- people for whom these issues have not proved obstacles may continue in the pipeline but leave for different reasons.

So what? Isn't being uncomfortable and dirty part of being a geoscientist? Why should we encourage people who don't like or are unfamiliar with the outdoors to study geoscience? Hopefully the answers to these questions are obvious….but what are some solutions? What strategies can be used to mitigate these perceptions and attitudes?

Dave Mogk discusses some of these issues in terms of planning logistics and reducing the "novelty" aspects of field-work. Many concerns can be addressed by giving students lots of information so that their unspoken and potentially embarrassing questions are answered (Mogk, 2006 and 1997). But what about the cultural and class issues that may underlie some of these concerns? Parental attitudes about career choice clearly influence college major decisions (Bembry et al., 1998). One solution is to make sure that students and their families not only see people from a range of cultures and classes doing and enjoying field work, but the same people working in the lab and reporting at conferences/teaching looking clean, neat and professional. Role models need not emphasize the discomfort of doing geoscience as if it were a badge of some sort --- as a profession, need to let students know that you don't have to "look like a geologist" to be one.

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LISA GILBERT, GEOSCIENCES & MARINE SCIENCES, WILLIAMS COLLEGE
ESSAY: "I'M GOOD AT SCIENCE, NOW"

A recent student thanked me for showing her that she was "good at science, after all."
The undergraduates in my Oceanography course are successful students, however, many of them are non-science majors and enter declaring "I'm not good at science!". In this course, students are relieved of this excuse early in the course with an authentic, hands-on research experience. The confidence they gain doing a short project carries them to propose and complete independent field- or lab-based research projects within the same semester. Most of them do not have the specific knowledge for a 'junior thesis' in the sciences, but the early success with finishing a piece of research gives them confidence that propels them to start and complete their own original research.

I think there are a many things we can do as instructors to get students fully engaged in our topic, even when they enter a course with trepidations or little specific background. I spend significant effort early in the semester helping students attain (a) a personal connection to science and (b) a sense of accomplishment with research. Weeks 2 and 3 (while we happen to be at sea) are devoted to an intensive field project. Students work in shifts to measure and sample the waters we sail through. Tremendous amounts of data are generated. Pairs of students are given manageable subsets of data to describe and interpret. Students write papers and we have a poster session at the end of Week 3. Students feel ownership of their data subset as well as interest in the poster session, since they were part of data collection and processing for other groups.

In Weeks 4 and 5, students are taken to new (local) field environments and asked to propose many potential oceanography research questions. Because they know what it is like to DO science, they have the background to design feasible semester projects. After submitting a proposal in Week 6, they spend the next 10 weeks completing a project they have created and about which they express great ownership and pride. These same students complete independent research in other subjects during the same semester. I don't have any data yet, but they report that the science project causes them the least anxiety, in part because they already have a model from early in the semester.

Some of these ideas were presented at the 2005 GSA Annual Meeting: Gilbert, L.A., 2005, Research-based learning in marine science at an interdisciplinary off-campus undergraduate program, Geological Society of America Abstracts with Programs, Vol. 37, No. 7, p. 446.

BOSILJKA GLUMAC, GEOLOGY DEPARTMENT, SMITH COLLEGE

ESSAY 1: DESIGNING GEOSCIENCE COURSES AROUND PROJECTS WITH REALISTIC SCENARIOS

One approach to considering the affective domain, especially student motivation, in geoscience courses includes designing assignments that demonstrate the relevance of the work that geologists do. The Sedimentology course I teach at Smith College is an example of a course structured around projects, most of which are field based. The projects are carefully designed to take advantage of the local geology and to address a variety of topics. To demonstrate the relevance of the work the students are asked to do the projects are designed to mimic real-life situations: for example, the students address concerns of a local farmer, or have roles as field conference organizers and collaborators (with paleontologists) on a multidisciplinary research project (for details please see:
http://serc.carleton.edu/NAGTWorkshops/sedimentary/activities/13884.html).
Students seem to enjoy such role-playing. Anecdotal evidence and course evaluations suggest that students perceive that they learn a lot in this course and that the knowledge and skills they acquire are useful for their future as graduate students, professionals and informed citizens. As an example, here is just one comment form a student (sophomore) in my Fall 2006 Sedimentology course:

"Thank you for teaching such an interesting class! The material was difficult, but I feel very accomplished. I remember at the end of my second semester first year my mother wanted to know what I had learned. I was hard pressed to think of something! It was extremely frustrating! Of course I did learn something, but I did not have a feeling of accomplishment or a good concept of what it was! If my mother asks me that this semester I will have so much to tell her! I feel very accomplished and I know that I have learned so much from this class. So thank you for teaching such a fantastic class."

ESSAY 2 - INTRODUCTION TO BIOTIC EVOLUTION: A CASE OF CANCER

An approach that carefully considers the affective domain in teaching the controversial topic of biotic evolution is described in a short letter by Leo F. Laporte (GSA Today, April 1998). This letter was written in response to Eugenie C. Scott's article "Creationism and Evolution: Still Crazy After All These Years" (GSA Today, January 1998). In his letter Leo Laporte states:

"The approach I have found most useful for my students is to make clear the distinct epistemological differences between the rival claims of creationists and evolutionists. The epistemology of each side is diametrically opposed: what they know, how they know it, and the limits of their knowledge. The creationist is unequivocally committed to textual content, namely the literal meaning of Biblical Genesis, and disbelieves anything that contradicts that content. The evolutionist, by contrast, is thoroughly committed to methods, namely drawing logical inferences from reproducible observations. Whereas the evolutionist will revise current content if the results of the method so dictate, the creationist has no method and simply relies on an inerrant text."

"I have found that focusing on the underlying epistemologies of different realms of knowledge – science, religion, the arts – is more instructive for students as a way for their discovering what is more likely credible and useful with respect to certain aspects of human experience. Thus, one should rely on the epistemology of science for the removal of a cancer; religious belief might console after the death of a loved one; and the arts can enrich aesthetic experience."

When I introduce the topic of biotic evolution to my students I first ensure that they are familiar with definitions of the terms evolution (change through time) and scientific theory (explanation of natural phenomena). I also like to clarify that the controversy among scientists is not whether biotic evolution happened but about how it happened. I then like to continue with discussion of some of Leo Laporte's ideas, with "the cancer case" providing an especially thoughtful and enlightening example.

PATRICIA (PAT) HAUSLEIN, BIOLOGICAL SCIENCES, ST. CLOUD STATE UNIVERSITY
ESSAY: LIFE'S RICH LESSONS LIE IN UNEXPECTED MOMENTS

I had knee replacement surgery this past summer. Since then I have been using a cane when I walk my dogs. The cane is one of those adjustable aluminum ones. A recent late afternoon we were walking our usual route out by the prairie and marshland. It was very cold and very windy. The wind was to my back for the first part of our hike, but we finally reached the halfway mark and we had to turn around and face the wind... I pulled, snapped and stuffed-in until I was satisfied no bare skin was exposed. So I turn... and started the long, cold march back to the car.

That's when it started; a flute sound, like a native wooden flute. Where was that coming from?
After a minute or so I finally realized it was the wind blowing across the open holes in my cane. As I turned it this way and that, or the wind blew harder and then softer, different notes came from my new flute. I played with it all the way back to the car and barely noticed how cold it was.

I, like many educators, have had the experience of teaching a lesson we've taught a hundred times before. It's a good lesson, well structured, easy to teach. But as the class time passes, it feels hollow, soulless. I'm bored with the material and so are the students, though, bless their hearts, they continue to dutifully take notes.

Perhaps halfway through, maybe even only 10 minutes in, we know. We've got to change directions, get off this path and try another. So we pause. The students just stare at us while our minds are racing, trying to think of a new way to go. And then we remember; we love this stuff. Which way does "love this stuff" go? So we turn into the wind and just start walking.

Then it happens, first, just a single note from one student. But then another joins in and another. By the end of the hour, the room is filled with song, one with rhythm and pitch to rival anything Mozart wrote.
And tomorrow I've got to do this all over again. But I know the wind will shift and I can't do today what I did yesterday. However, if I have "The Courage to Teach" we'll create another song, different, but the title will be the same, "I love this stuff!"

"The Courage to Teach" is a book by Parker Palmer.

JENEFER HUSMAN, PSYCHOLOGY IN EDUCATION, ARIZONA STATE UNIVERSITY
ESSAY: LEARNING TO MOTIVATE MY OWN STUDENTS: THE CONFESSIONS OF ONE EDUCATIONAL RESEARCHER

After years of teaching graduate level course, I was asked to take on an undergraduate course for pre-service teachers. My first semester, I was not a successful teacher, the comments and evaluations I received from students after my first semester teaching the course were far below what I expected. What was worse, the number one negative comment was that they found the course not useful and not motivating. This was particularly disheartening because the focus of my research is post-secondary student academic motivation and particularly the importance of students' perceptions of the utility of their course work for their future goals (Husman, Derryberry, Crowson, & Lomax, 2004; Jenefer Husman & Lens, 1999; Shell & Husman, 2001). Additionally I strongly believe that the students in my classroom need the content to be successful as future teachers. So the content is useful, I know how important perceptions of utility and student motivation is for learning (Malka & Covington, 2005; Robbins, 2004), I just was not applying that learning to my own teaching. I knew I had to change my course to do that.

I focused the changes I made to the course using the results of some of my own, and others, research. First, I wanted to increase students sense of autonomy and control (Vansteenkiste, Lens, & Deci, 2006). Second, I wanted to establish small "learning communities" within this large (70 student) undergraduate course (Shell et al., 2005). Third, I wanted to provide students an opportunity to make their own connections between the course content and their future goals (Husman & Lens, 1999).

My decision to increase students' sense of autonomy and control stemmed from my reading of the literature on Self-Determination Theory. These theorists argue that human beings have a need to control and shape their own lives (Vansteenkiste, Lens, & Deci, 2006). Students, however rarely experience this in the course of their own education. In my class, the students have many opportunities to directly influence their curriculum. Each week, the students must write two essay questions; these essay questions are turned in on Tuesday. On Thursday, the students come together in groups and write an essay, based on five essays chosen from those turned in on Tuesday. The students know they are directly influencing their own assessment, and they have an opportunity to choose among several topics of assessment.

The group essay writing project, although difficult for the students at the start of the semester, creates a strong sense of community amongst the students. I based my construction of this aspect of the assignment on Social Learning Theory (Zimmerman & Kitsantas, 2002). Through the need to construct a coherent group product, students model for each other how they think about the course content, how to transfer thoughts into organized text, and how to read the text for important information. Although I am aware of the research that has proven peer modeling increases student achievement and motivation (Zimmerman & Kitsantas, 2002), I am still surprised when I see it work so well in my own classroom.

The third major change I made to my course was the addition of a writing assignment. Specifically, I asked the students to choose one week's content to focus on (after they had the opportunity to participate in lecture, group essay writing, and group discussion) and write an essay describing why that week's content was important for teachers to know. In my own research, I have consistently found that simply telling students that content is useful is probably not effective; students need to come to that understanding on their own. Students need to be given the opportunity to envision their futures, and consider how what they are doing now might be related to that vision.

The changes I made to the curriculum three years ago have paid off. I now receive more comments about how useful and motivating the course is. Additionally, I enjoy the course more; motivated, enthusiastic, and optimistic students are simply more fun to teach than bored, frustrated students.

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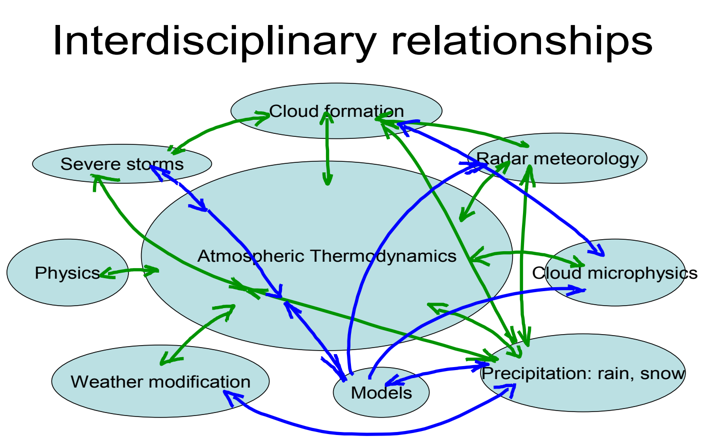
DOROTHEA IVANOVA, DEPARTMENT OF METEOROLOGY, EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

ESSAY: SIFTING THROUGH ONLINE INFORMATION: CRITICAL THINKING IN THE LEARNING PROCESS

Learning how to learn is an important component of geoscience education. In our age of overwhelming boom in science and rapidly advancing instruments and technologies – sifting through geoscience information is not simple. Weather Information Systems, Remote Sensing techniques, and Atmospheric Climate Models are constantly improving and the information becomes outdated fast. Therefore, having the ability to find reliable data sources on the Internet is crucial. This is an important skill that I am trying to develop in my students.

I have tried different critical thinking techniques and internet training lab sessions in each of the courses I teach.

- In the beginning of the semester we start with the most fundamental questions the students should be able to answer at the end of the course. This is our goal, all of the learning modules during the semester contribute to finding and explaining the answers to these fundamental questions.
- Then we introduce a conceptual diagram like the one below, that we discuss in the Atmospheric Thermodynamics class (provided as an example here):



- This diagram is blank in the beginning of the class. Only the *Main* course subject is included in the center. During my work with a team of colleagues interested in the critical thinking in the learning process, I was introduced to this powerful concept. We discovered that the students' critical thinking skills and interest in science, and geoscience understanding can be increased by creating conceptual diagrams, helping the learning process.
- Each course module contributes to the relationship between the main course subject on the diagram and other subjects (disciplines) that are introduced through the course of the semester.
- After each internet course-related lab session, the students themselves make the color connections between the subjects on the diagram, but not before they explain for their colleagues what information they have discovered online, and how what they found justifies the reinforcement of the relationship they create on the diagram. Then other students are encouraged to provide more evidence and their own findings and explanations about the relationship that was just created in green or blue. Therefore we employ the learning technique: find the information yourself → restate in your own words → give example → prove your point. I believe this is a very powerful technique stimulating the critical thinking in the learning process.
- At the end of each course we use the diagram completely finished by the students, the current course-related interesting articles and papers, found by them during the internet training lab works, other online information and everything that we study during the semester to answer the fundamental questions we posed in the beginning.

The survey at the end of the course encourages me to think that the students find these techniques interesting and engaging which broadens the learning affective domain.

JEFF JOHNSTON, CENTER FOR TEACHING, VANDERBILT UNIVERSITY

ESSAY: MEETING THE LEARNING GOALS WITH A BELOW AVERAGE COURSE

During the fall 2006 semester I taught a first year writing seminar entitled "The World's Oceans in the Global Environment," a course designed to introduce students to important topics in marine science in the context of Earth systems science, as well as key issues in ocean policy (e.g., fisheries, implementation of marine protected areas, etc.). As a writing seminar, most student work during the semester was in the form of writing assignments.

Information from a variety of sources (performance on assignments and the final exam, comments written on the last day of class, and feedback provided by the college administered course evaluation and the Student Assessment of Learning Gains (SALG) survey* at the end of the semester) indicates that students made significant gains in their understanding of Earth system science, particularly the workings of the marine environment. They are also much more aware of the current threats to the world's oceans and understand some of the implications of these threats to human society. Information from the above sources also indicates that the writing and information literacy goals of the course were largely met.

Despite these successes of the course, overall the students rated the course below average and rated my effectiveness as an instructor in communicating with the class and in stimulating their interest in the material below average (< 3 on a scale of 1-5). I knew going into the semester that motivating students to prepare for class and then to engage them in meaningful discussion would be a challenge, and indeed that was my biggest frustration with the course. Results from the course and SALG evaluations show that it was the student's biggest frustration as well. I am very interested and enthusiastic about the course topic and so I'm disappointed that a number of students were bored by me and the course. It is clear to me that my inability to engage students in the affective domain played an important part in the low student satisfaction.

I hope to teach the course again next year and I need to figure out how to significantly increase student satisfaction with the course. I see paying greater attention to the affective domain as a critical piece in improving this course.

* Information about the SALG instrument is available here: http://www.wcer.wisc.edu/salgains/instructor/

MEGAN JONES, GEOLOGY, NORTH HENNEPIN COMMUNITY COLLEGE
ESSAY: CASE STUDY ESSAY ON AFFECTIVE DOMAIN IN GEOSCIENCE TEACHING OF EVOLUTION

In teaching evolution, the affective domain plays a significant role in my students' learning. As we all know students come into physical or historical geology with diverse ideas, information and attitudes about evolution. I have found that my students need a longer period of time, relative to other topics, through which to process ideas about evolution in both their cognitive and affective domains, with affective domain being the far more complex side to reach. I usually take 2-3 lecture periods, one 3-hour lab period and some out of class time necessary for students to do some writing and web-based assignments as we go through the evolution module.

Probably the most important and effective technique that has worked for me is to demonstrate to them on many levels that I am human and that scientists are human. For example, scientists have emotions, families, financial problems, as well as depression and other ailments that all humans fall prey to. Early on in the semester I bring this idea to the class and then reiterate it wherever possible. When they start to understand what science is and how it works, they also recognize that it is human beings that do science. We also discuss the distinction between a scientific conclusion based on data and an opinion or feeling about the conclusion. By the time we get to evolution, students have had several opportunities to work with data, pose hypotheses, make some inferences, draw some conclusions from their work and determine what their opinion or evaluation of the conclusion is. My first goal for them, when starting evolution, is to think and write about their opinion or feelings about evolution, so as to be able to distinguish that from the scientific data/evidence about and the historical development of evolution.

I use a diverse set of activities for our evolution module, including several from the PBS series on evolution. I use most of a 3-hour lab period or part of lab and one lecture period to watch the first PBS segment (2 hours) on Darwin. I have had tremendous success with this because it is a story-like rendition of Darwin's own affective and scientific journey to the Origin of Species. Students relate to this because they see that he is human and that he is being pulled is many different directions and he has to decide what to do with all of his ideas. I have students do a couple of very simple exercises associated with this first segment from the PBS evolution website. First, they read through several excerpts of Darwin's field notes and on a world map, they plot the location of the journal entries that they have. Second, they read two, one-page abstracts by each Darwin and Wallace, identify similarities and/or differences between their ideas (students are always amazed that two different people can come up with the same ideas, at the same time). Third, I ask them to tell me what evidence supporting evolution & natural selection from the video and readings they think is the most compelling and to explain the evidence and why they feel it is compelling. By the time we go through these first three activities students have a good sense about the scientific evidence for evolution and how the whole theory of evolution was developed.

After this introduction to evolution, the students are ready to move on to some more meaty exercises. I have lectured on the nuts and bolts of natural selection and answered the questions that have arisen as a result of the Darwin segment and the lecture. The next exercise that they do is a three-part, web-based writing lab on evolution created by Pamela Gore (http://gpc.edu/~pgore/geology/historical_lab/evolutionlab.htm) This lab includes sections on the basics of evolution, the origin of whales and science vs. pseudoscience. The students work on this over a week or so, this way they can do some of the reading, think about it and then write their response. By the time they are finished with this exercise and some of the lab manual exercises the students are satisfied with what we have done. All students say that they have a better understanding of the scientific theory of evolution. Some students are now able to differentiate between their opinion or feelings about evolution and the science of evolution. Often times this is a great comfort to students who come into the topic very anxious and conflicted. In large part, I think that the introduction to Darwin might reduce some of the students' novelty space (new for me from one of the ancillary readings). I would like to understand more about novelty space and how to intentionally work with students on it.

CLAUDIA KHOUREY-BOWERS, TEACHING LEADERSHIP AND CURRICULUM STUDIES, KENT STATE UNIVERSITY STARK

ESSAY: TEACHING EVOLUTION TO ALL THE MARYS

One fundamental topic in the discipline of biology is the process of evolution. In my early days of teaching, I would preface the brief unit on evolution by telling my high school sophomores, "Evolution is something you need to know, but don't need to believe." I taught the concept in a straightforward, discipline-focused way.

My ideas about teaching evolution to students started to expand when I began teaching at in a teacher preparation program. One of my students, Mary, was a devout Mennonite. She was also intellectually curious, hard-working, outspoken, and had a great sense of humor. Mary would frequently come in my office during office hours (imagine that!) just to chat with me about science education and the middle childhood program. During one of our conversations, Mary brought up the issue of teaching evolution. In our frank conversation, Mary told me that her religious beliefs were inconsistent with "believing in" evolution. Appreciating her frankness, I responded in kind, telling her that if she intended to teach in a public school, it was her ethical obligation to teach evolution as a scientific principle. I also informed her that even in some religious-affiliated high schools, the teaching of evolution (for knowing, not believing) was expected. Mary agreed that she could and would teach evolution in a public school setting.

Some of my students had very defined religious beliefs, some had none, either by choice or by chance. But whatever their belief systems were, my choices in how and what I taught in my science classroom were also guided by the principles of science, my interpretation of those principles, and my values as a person and as a teacher. How could I best serve the needs of my students, as a community of learners, to engage in scientific thinking? I felt the need to demonstrate recognition and respect for each Mary that I would have in class, yet at the same time promote unequivocally the importance of teaching science, not religion, in science class. The Structured Academic Controversy unit was born! Use of this constructivist strategy avoided potential areas of conflict by focusing on learning goals to create a positive learning experience. The learning goals promoted teaching of evolution without: a) requiring students to take a dualistic stance; b) straining classroom interactions between students with diverse views; or 3) marginalizing students whose personal beliefs were diverse from the majority.

KAATJE KRAFT, PHYSICAL SCIENCE, MESA COMMUNITY COLLEGE

ESSAY: CREATING A SCIENTIFIC DISCOURSE COMMUNITY IN MY GEOLOGIC DISASTERS CLASS

I teach at a Community College where I have a diverse blend of students taking my introductory geology classes (many of whom are in their first college level science course). Every semester, there is always a decline in enrollment throughout the semester. Some are due to legitimate reasons, but many students drop out or just choose to stop coming to class. I've tried to create more in-class activities in past semesters, and yet that seems to change little to this trend. This past year I've embarked on a project to create my classroom into a Scientific Discourse Community, in the hopes that the affective experience is enriched along with the curriculum itself.

I wanted to create a classroom that not only covered the required competencies, but also created an environment where students wanted to come to class. I have been involved in an NSF-funded research project within my district in which we have worked with local Middle & High School Science teachers to work on creating a Scientific Discourse Community within their classrooms as well as ours (Communication In Science Inquiry Project, CISIP: ESI-TCP Award #: 0353469). A Scientific Discourse Community creates a culture that fosters student learning. Students learn to negotiate meaning of and in science by interacting with each other and internally synthesizing a shared understanding. This community develops through extensive student-student interaction by engaging in the process of doing science.

While doing true geoscience inquiry is a challenge within a lecture classroom, I chose to create a case-based study process for my Geologic Disasters class in which students would examine data from different disasters and learn to make their own claims based on evidence they collect from the given case study. Throughout the class, they are actively engaged in working together and sharing information with each other, modeling portions of the scientific process. As a result, I've watched the classroom transform from a Teacher-Student guided conversation to a Student-Student guided conversation.

On a qualitative level, I have seen the level of conversations between students advance to probing one another for details on evidence that supports claims and working hard to analyze new situations for potential disaster problems. Students seem to have a positive attitude toward class and attendance is overall stronger on a day to day basis.

On a quantitative level, while the overall current grade averages are lower than past semesters, the attrition rate has decreased significantly. The past three semesters are a snapshot of my previous attitrition rates with an average between 16-19%, however this semester it was only 10.8%. This is only one semester, however current qualitative and quantitative trends show a potential positive experience for students in the current student-driven climate rather than previous lecture-based (with occasional small group activities interspersed).

For more information on Scientific Discourse Communities see:

Yerrick, Randy (2004) Establishing Scientific Classroom Discourse Communities: Multiple Voices of Teaching and Learning Research. Mahwah, NJ, USA: Lawrence Erlbaum Associates, Incorporated.

Lemke, J.L. (1990) Talking Science: Language, Learning, and Values. Norwood, NJ: Ablex Publishing Corporation.

DAVID MCCONNELL, DEPARTMENT OF GEOLOGY, UNIVERSITY OF AKRON

ESSAY #1: OFFICE HOURS

I taught a large introductory earth science class in spring semester 2006. I encouraged any student who wished to improve their exam performance, especially those who failed the first test, to visit me during office hours to discuss test preparation strategies. Despite the large class size, few students showed up.

The way a student chooses to explain a test result can provide an indication if they will be successful in the class. Students often attribute success or failure to a combination of factors that they view as: 1. Internal or external causes for success or failure typically tied to the student or instructor respectively: 2. Factors that are considered stable or fixed for the semester (e.g., lousy textbook) or that are unstable and may be modified to improve performance (e.g., visit to office hours when needed): and, 3. Situations that the students consider controllable or uncontrollable that may allow students to make necessary changes or may act to prevent opportunities for improvement. Students are more likely to be motivated to change their learning practices where they perceive that their lack of success is attributable to internal, unstable, controllable factors.

The next semester I decided to offer an incentive for students to attend office hours so that I could address the factors that were limiting their exam performance. I assigned 10 extra credit points (total points from semester assignments = 1000) for a 30-minute office hour visit. I also changed the way I managed office hours. Instead of having a consistent hour at the same time every other day, I adapted a technique my education colleagues use. Each week I identify a series of 30-minute blocks and post them on a timetable on my door. A typical week may have 10 blocks but prior to exams there may be as many as 20. This requires that most weeks I devote more time to direct contact with students, a key attribute of best practices in undergraduate education. Few students came to the office hours prior to the first test but the test results provided sufficient incentive to have students start signing up. Prior to the second test, 30 students visited office hours and discussed their performance in the class. The average first test score for visitors was 66.9% (vs. 71.9% for other students, n=205). While most of these students had performed poorly on the first test, five had scored 80% or higher.

Students typically attributed their poor performance on the first test to internal factors (they did not put in enough effort), that were unstable and controllable (they would spend more time preparing for the second test). We discussed their test preparation strategies and students would often tell me relied heavily on flash cards. None of these students scored above 70% on the first exam. I pointed out that such methods were helpful for vocabulary but were not as effective for promoting conceptual understanding. I encouraged the weakest students to seek help from the university's tutoring center and to consider using some additional test preparation strategies (e.g., concept maps). We spent almost half of the visit discussing other classes and high school experiences were students had done well in class. Finally, I pointed out that other students who had performed below their expectations on the first exam had been able to do well on later exams and I expressed confidence that they could do the same. The average score on the second test for office hour visitor was 72.3% (vs. 72.8% for other students). Two-thirds (67%) of office visitors improved their score on the second exam. Only 48% of the rest of the students improved their scores. Consequently, the office hour visits appear to have helped students to improve their exam performance more readily than they could have on their own.

DAVID MCCONNELL, DEPARTMENT OF GEOLOGY, UNIVERSITY OF AKRON
ESSAY #2: THE EFFECT OF GROUPS

One of the most reluctant changes I made to my teaching was the introduction of groups into large classes. However, time has shown that this change was perhaps the most important improvement I have made to my teaching. Class evaluations consistently mention the benefits of groups and the level of student engagement in class has clearly increased. Whether it is the immediate buzz of noise that fills the classroom as students discuss a problem or the high fives that follow a successful answer, the groups have gone a long way to improve the learning environment, and making class a "fun" place to be.

During research with a team of colleagues, we discovered that we can increase students' logical thinking skills and conceptual understanding of geoscience concepts if we create a learning environment involving groups of students working on challenging conceptual problems in class. We were curious if these improvements were primarily a result of working in groups or were more attributable to working on exercises that required the application of higher order thinking skills. To investigate this question, one instructor taught two sections of the class using the same learning exercises and using collaborative groups in one class but not in the other. Both classes received the identical lectures and class materials. Students in the class without assigned groups were not prevented from working together, though it was not encouraged by the instructor.

Overall course grades for students in the section using assigned groups were 5% higher (80% vs. 75%, $p<0.01$) than in the section that employed similar exercises without the benefit of groups. The overall result was not unexpected since the group work concept has been shown to be successful in many situations (Nelson, 1994; Paulson, 1999; Lord, 2001). Students in structured groups learn from one another and are more likely to get their questions answered as they strive to meet common goals and objectives. They become more socially connected and have more opportunities to address their misconceptions. This is particularly true in large format sections where individual attention from the instructor is at a premium.

The advantage gained by using groups appears to help all students, but the effect is most profound in students with the highest (abstract) logical thinking skills. This was unexpected and goes against a common rationalization for not using groups – "the weak students will pull down the strong students." Perhaps abstract students fare better in the group environment because they have more advanced metacognitive skills that allow them to readily recognize and address their misconceptions as they attempt to explain concepts to peers. This interaction then reinforces the concept for the abstract thinker and better prepares them for later assessment opportunities. In contrast, the exposure to the learning exercises themselves may be the more significant factor for other students with a history of learning strategies that rely heavily on memorization and recall.

For more information see:
McConnell, D.A., Steer, D.N., Owens, K., & Knight, C., 2005, How students think: Implications for learning in introductory geoscience courses: Journal of Geoscience Education, v. 53, #4, p. 462-470.

DAVID MOGK, DEPT. OF EARTH SCIENCES, MONTANA STATE UNIVERSITY
ESSAY 1: TEACHING IN THE FIELD

"We're going on a field trip!" the instructor announces enthusiastically to the class, expecting that all students will share this enthusiasm. Field trips are part of the culture of the geosciences and of geoscience education, and much of what we see and do on a field trip is second nature to us. We know what to expect during the trip, what is expected of us, how to function (and behave), and how we will benefit from the experience.

But, what is going through the minds of our students: Where the heck are we going? What are we going to do there? I've never done anything like this before, and I'm very unsure about what I have to do. Will we have to hike a long way, will I be able to keep up? What about the weather, will we go if it rains? I'm terrified of snakes! What about bathroom stops? Will we eat on time? I have hypoglycemia/diabetes and really need to regulate when and what I eat. Will we be back in time for me to pick up my kids at day care? I still don't understand how to use a Brunton compass and what it does. What do we have to turn in for credit, and how will it be graded?

Facing all of this anxiety and uncertainty, how can learning possibly happen? Following the work of Orion and Hofstein (1994), learning cannot effectively happen until a student's "novelty space" is minimized. There are three aspects of novelty space that must be considered when planning and implementing a field exercise:

- geographic novelty, which refers to the students' familiarity with the field trip site,

- cognitive novelty, which refers to the skills and concepts the students encounter and are expected to master on the field trip, and
- psychological novelty, which considers the social aspects of field trips, and related issues such as personal safety and comfort.

The larger a student's novelty space, the less the student is likely to learn. Therefore, these factors should be carefully considered when planning an implementing a field trip to optimize student learning in the field. Mogk (1997; and http://serc.carleton.edu/files/NAGTWorkshops/petrology03/Field_Notes.doc) further discussed the concept of novelty space, and related issues of setting appropriate goals, objectives and outcomes for learning in the field.

Field trips are often cited as an important means to recruit and motivate students to learn geoscience--but this will be true only to the extent the field trips are memorable and positive learning experiences.

References:
Orion, N., and Hofstein, A. (1994), Factors that influence learning during a scientific field trip in a natural environment. Journal of Research in Science Teaching, 31(10), 1097-1119.

Mogk, D. W., (1997), Field Notes, In: Brady, Perkins and Mogk (eds.), Teaching Mineralogy, Mineralogical Society of America

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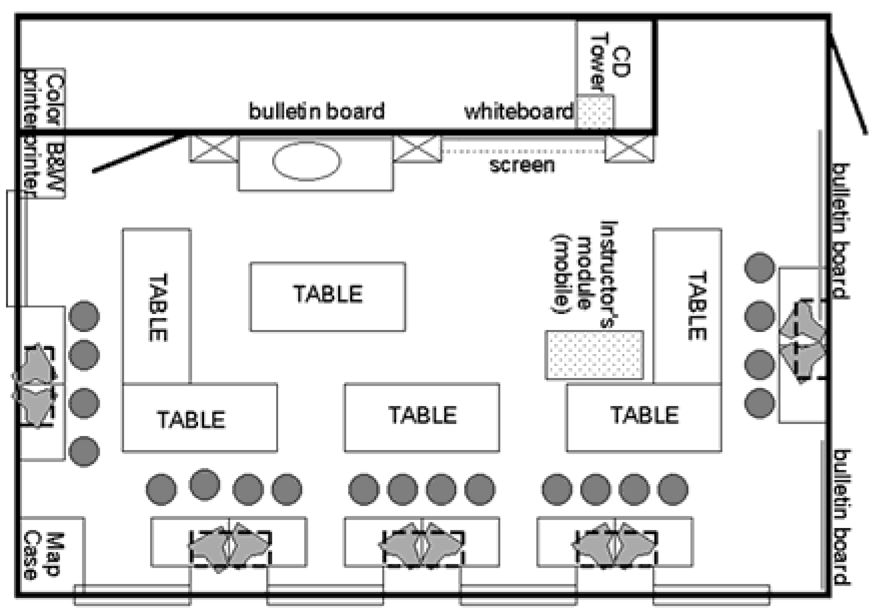
DAVID MOGK AND WILLIAM LOCKE, DEPT. OF EARTH SCIENCES, MONTANA STATE UNIVERSITY
ESSAY 2: LEARNING ENVIRONMENTS - DESIGNING A COMPUTER LABORATORY

Our department had the opportunity to add computer stations to our Introductory Physical Geology laboratory. In planning for the installation of the computers, we had to make informed decisions about the design of the laboratory. Would the computers be installed on desks in rows looking to the front of the class, in "islands" (e.g. using hexagonal tables), arranged around the perimeter of the room…? Our final design is pictured below. Here's how we selected the design for this laboratory:



- We started by asking "what instructional modes will likely be used"? We anticipated that the computers would be used for some "canned" exercises (e.g. on-line activities developed for direct use) and some open-ended discovery exercises using the computers (e.g. students search the web for information). We also wanted to maintain our traditional use of physical materials—maps, rocks, groundwater models, etc. And our Environmental Geology class does a lot of group activities including debates, preparing poster sessions, and other types of presentations.
- We decided to place the computer stations around the perimeter of the room so that the instructor stand in the center of the room and scan across all the work stations to make sure that students were

generally on task when using the computers. The students also had to have eyes front when the instructor (or other students) were making a presentation—not looking at or over the computers (or surfing or playing videogames). We were able to purchase 10 computers, which meant that two students share each computer to do assigned tasks. The keyboard is located on one side of a two-person desk, leaving room on the desktop to place documents, take notes, etc. The monitors are turned so that two students can see the screen at the same time. Two computers are stationed side-by-side so that we can form 4 person working groups for collaborative assignments.

- Printers have been the bane of our existence due to cost and maintenance. We originally had planned for students to print off completed lab assignments at the end of each class. However, we have had to take these off-line. But, with ease of access to portable data storage devices (e.g. "thumb" drives), the students are able to take their class work with them, revise if needed, and print their work on their own printers.
- The computer boxes were originally placed on shelves on the wall above the monitors to keep them off the floor and away from dust and slush (during Montana winters). But, to accommodate some of our disabled students, some of the computer boxes are now placed under the tables to facilitate access. All of the computers are equipped with head phones to access audio programs so students can listen and not disturb neighbors at adjacent stations. In one instance, we had a legally blind student, and we installed special software that enlarged text and images (rather than an audio substitute) so that she could have access to the computer-based resources.
- Other tables are arranged in a U-pattern in an inner ring just behind the computer stations. This was done so that students could turn around in their seats and have access to physical materials—rocks, lay out maps, etc. We believe that it is important for students to be able to easily integrate computer-based resources and manipulative materials. The U-shaped distribution of the tables also allows all students to be able to see each other during whole-class group discussions.
- A computer station with a projector is dedicated for the instructor and can be rolled to the front center of the room as needed—this allows the instructor to make presentations, and is also used by student groups making presentations, debates, etc. This station is used occasionally for overflow attendance or if another computer malfunctions.
- We were constrained to design the laboratory around the existing physical structures which could not be moved: white board, bulletin boards, sink, windows (indicated by rectangles at left and bottom of diagram), and structural supports (indicated by X's).

This room configuration gave us the most flexibility to accommodate a variety of instructional modes: lecture, discussion, demonstration, independent and small group work on the computers, integration of computer-based and physical resources, and ability to form small groups of 2 or 4 for collaborative learning. This also helps the instructor to be aware of what students are actually doing during lab time, and facilitates rapid interventions if students appear lost or distracted. We have used this room configuration for the past 8 years with no significant need to modify or reconfigure. Although we have done no formal assessment of student attitudes about this set up, the students appear to work well in this environment. The design has withstood the test of time.

An excellent resource on designing Learning Spaces was produced by Project Kaleidoscope, What Works Volume III: Structures for Science, A Handbook on Planning Facilities for Undergraduate Natural Science Communities. "This step-by-step guide to planning facilities is intended for use by colleges and universities that are thinking about, or in the process of planning for, new or renovated spaces for their undergraduate programs in science and mathematics." See: http://www.pkal.org/collections/VolumeIII.cfm

RANDY MOORE, PSTL/BIOLOGY, UNIVERSITY OF MINNESOTA
ESSAY: EFFORT, APTITUDE, AND PRIOR EXPERIENCE IN INTRODUCTORY SCIENCE CLASSES

For many years, I have studied how students' "aptitude" and academic behaviors affect their learning of introductory science. For example, on the first day of classes, more than 90% of students in introductory science courses believe that effort is the most accurate predictor of academic success. Students know which academic behaviors are important for success; they predict that they will attend 90% of lectures, attend all labs, attend all help-sessions, and take advantage of all opportunities for extra-credit work. Not surprisingly, they are confident that they will earn high grades, Despite this optimism, many students do not follow through on their first-day-of-classes' expectations, and their grades suffer accordingly. Academic success in introductory science courses is strongly associated with effort-based behaviors, but only weakly associated with aptitude (e.g., ACT scores). That is, introductory science courses select primarily for effort, and secondarily for aptitude.

We have also tried to determine how students' prior experiences in high school may have conditioned their academic behaviors in college science courses. For example, more than 90% of "average" students in high school earned an A or B in their high school science courses, yet most of these students claim that these courses were not challenging. In this regard, the lax standards of many high schools contributes significantly to the academic "shock" that many students encounter in college science courses.

We have also studied how students' views of evolution are affected by their previous academic experiences with evolution. Students enter introductory science courses with a diverse range of academic experiences involving evolution. Approximately half of the biology teachers in public schools teach evolution but not creationism, less than 5% teach creationism but not evolution, 25% teach evolution and creationism, and 20% teach neither evolution nor creationism. Students who enter introductory science courses have negligible understandings of, and many misconceptions regarding, the geological evidence supporting evolution. A key ingredient in the teaching of evolution may be an emphasis on this evidence (e.g., the ideas by Steno, Hutton/Playfair, and Lyell). Indeed, students' understandings of evolution have increased every time I have increased my emphasis of these topics.

MARTINA NIESWANDT, CURRICULUM TEACHING AND LEARNING, ONTARIO INSTITUTE FOR STUDIES IN EDUCATION OF THE UNIVERSITY OF TORONTO (OISE/UT)
ESSAY: A DIALECTICAL RELATIONSHIP BETWEEN STUDENTS' MOTIVES AND INTEREST AND TEACHING APPROACHES

The following case study focuses on how students' perceptions about a science course are reflected in their motivation and interest in learning and how this relates to the teacher's teaching approaches. The case study is part of a research project investigating how students' motivation and affects (interest and attitudes toward science) influences their learning of science concepts in a one-year grade 11 Science General course. The study was conducted at an independent university preparatory all boys' school, which has a strong academic reputation. The grade 11 Science General course was being offered at the school for the first time. It was intended to meet the students' need for a senior science credit while providing an alternative to the typical university preparation courses in physics, chemistry, and biology. It is not accepted as a prerequisite for studying science at university. It was also profiled as an environmental science course with an implicit and probably unintended emphasis on its lower status in contrast to the discipline-oriented science courses. Thus, the course was only chosen by students not planning to pursue a career in science.

The course used a curriculum that I developed in cooperation with the teacher. Based on the Ontario Science Curriculum it emphasized the role of science and technology in daily life and in relation to social and environmental issues. The course units included topics such as nutrition, waste management, space and micro-gravity, and technologies in everyday life. Using student-centered teaching strategies the topics were taught focusing on ethical, environmental, and economic issues that involve various societal viewpoints. I collected data using a mixed-methods approach: weekly classroom observation, individual student and teacher interviews and questionnaires administered three times throughout the school year. For this case study, I focus on students' and teacher interviews.

The analysis of the series of students' interviews reveal five major perceptions of the course, which did not change throughout the school year: "Dead-end", "just a credit", "for non-science people", "not a real science course", and "everyday knowledge accumulation". The boys used these perceptions as a justification for why they put only a minimum of effort into it; it does not count as a prerequisite for any of the subjects that they want to study at university; it "only" gets them there. This pragmatic approach is also linked to students' perception of not being able to do the real science. They stressed that if they were capable of doing science, then they would not have enrolled in this "not a real science course" or "course for non-science people"; instead they would have enrolled in any of the discipline-oriented courses. These various themes emphasize how deeply the boys internalized the school's mission of high academic standards valuing only discipline-oriented university-preparation courses positively and viewing them as the standard of imparting academic knowledge. Yet, students' perception also reflects two socioculturally determined public views: First, of science as a subject for only smart people (Bell & Lederman, 2003) and second, that an understanding of environmental or socio-scientific issues (Sadler & Zeidler, 2005) such as global climate change, land-use decisions, cloning or stem cell research as not being real science. However, it was these topics that resulted in a situational change of their interest and motivated them to develop an understanding about topics that had relevance for their future lives. This situational change did not, however, result in a change of the boys' general motivation and interest. Instead, their perception of these topics as easy and everyday, their internalized socioculturally determined view of science, and their internalized school mission were more powerful messages and were incorporated into the students' motivational structure.

The teacher, Amanda, was aware of the boys' dominant perceptions of the course. However, through highlighting the importance of the connections of science to everyday life she was able to challenge their negative feelings towards science sporadically. It was these connections that triggered situational change in students' motivation and interest and at the same time, kept up Amanda's on-going effort and motivation to find interesting activities and topics alive throughout the school year, although by the end her frustration with the course was clearly evident.

These results hint towards a dialectical interdependence of students' individual motives and interests and teacher's teaching approaches. They also suggest the importance of integrating more STS topics in our science curricula or, more radically, teaching scientific concepts through their immersion in STS topics.

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EDWARD NUHFER, GEOSCIENCES, IDAHO STATE UNIVERSITY
ESSAY: REPLACING FEAR AND DISTASTE OF SCIENCE IN STUDENTS' PRIVATE UNIVERSES

James Rhem, founder and editor of National Teaching and Learning Forum, was the first person to get me thinking seriously about the importance of the affective domain on the process of becoming educated. My finally internalizing the importance of the affective domain on professors' ability to teach and students' ability to learn was a breakthrough for me in understanding how to replace fear, low confidence, and apprehension with interest, enthusiasm, and fascination. It proved equally as important to faculty development as to student education. Utilizing the affective domain to benefit involves creativity of a kind that is often not developed in higher education-at least in that of scientists. It involves attention to things such as light and color of classrooms, the benefits of starting a class with music, and thinking of enacting instruction in our classrooms in much the same ways we think of welcoming guests into our living rooms.

Often, one will find seniors and juniors in introductory courses because fear and apprehension led to these students trying to escape fulfilling the science requirement until the last possible semesters. These students hardly feel welcome in the environment they perceive is about to befall them. Their feelings may result from bad experiences in K-12 classrooms and/or negative misconceptions about science and scientists perpetuated by the popular entertainment and media industries. From what are admittedly only my personal experiences from speaking with my tutors and students from other countries, the particular fear of science and mathematics is more prevalent in Americans than in other cultures. Fear and distaste are part of the affective domain but are not natural reactions or spontaneously generated feelings. Affective feelings acquired in specific ways become inextricably associated with specific cognitive material. When negative, they present challenge to both students and instructors. The strength of erroneous scientific preconceptions demonstrated in the "Private Universe" project in 1987 showed the incredible tenacity of preconceptions and their resistance to modification. Successfully overcoming these requires replacement of a neurological network that holds unproductive concepts with a better network, rather than trying to coax an old network into functioning correctly. Interactive engagement design that involves the cognitive, affective and psychomotor is effective. Lecturing that attempts to address only cognitive content while "steering clear of that touchy feely stuff" is not surprisingly, ineffective, because the latter tries to cause change by using less of the brain than was used to form the misconception. There are good cognitive explanations for interactive engagement in groups consistently producing better understanding of concepts than does lecture, but there are also good affective reasons that include increased feelings of support generated by nonverbal cues, development of friendships, satisfaction of contributing, more opportunities for ownership and power to act, and less fear of humiliation for "being wrong." The "thin slices" research of the early 1990s confirmed the power of the affective domain in initial experiences' shaping of students' evaluation and satisfaction with their longer-term educational experiences. This lasting power came mainly from affective, rather than cognitive influences. To a fractal thinker, it reveals why we need to employ the affective domain early in our classes, courses and curricula.

MATTHEW NYMAN, EARTH AND PLANETARY SCIENCE/NATURAL SCIENCE PROGRAM, UNIVERSITY OF NEW MEXICO

ESSAY: STARTING OFF RIGHT: INTRODUCING STUDENTS TO THE INSTRUCTOR AND THE SCIENTIFIC PROCESS

I teach a physical science course for pre-service elementary teachers that includes topics in physics, astronomy and earth science. For the past three semesters, I have been teaching the course with physics content covered through investigation of geologic processes. For example, I use seismology as an opportunity to learn about wave phenomena, and plate tectonics to understand a variety of concepts such as heat transfer, gravity, and Newtonian physics. The primary objective of this course is to provide standards-based content using a range of instructional strategies including direct instruction, hands-on activities, guided inquiry and student-driven inquiry. A second objective of the course is to address and affect the common negative attitudes that many of the students bring with them to the science classroom so that they don't carry those attitudes into their future classrooms. In this essay I will discuss one activity that I use to address this issue.

One of the first goals of my physical science class is to discuss the scientific method as a means for understanding natural processes and phenomena. I explain to my students that the basis of the scientific method is asking testable questions. I then explain that part of answering questions is to make accurate observations and generate inferences from the observations. To illustrate this process I conduct an activity called Do You Know Me?. I open this activity by explaining to the students that they are using scientific skills everyday when they make inferences or conclusions about other people based on simple observations; the big, muscular person must lift weights, the person in all black clothing is a Goth, etc. Next I ask the students a series of 10-15 questions about me, for example: "How old am I?", "Am I married?" (I usually take off my wedding ring), "Do I have children?", "What kind of car do I drive?", which they answer on a sheet of paper. I then provide answers to the questions, sometimes laced with humor; for example, I joke that answers about my age carry grade penalties if they guess too high. We also discuss the nature of the questions; which questions were easy to answer, which were hard, what evidence was used, what biases or preconceptions influenced their inferences (for example, many assume that the lack of a wedding ring indicates that I am single). We also discuss the fact that they do not generally test their hypotheses, perhaps their inferences would not hold up under further investigations. This simple exercise in observations is followed in the next class period by Earth Observations Day in which students use a variety of visualizations to recognize patterns in earth related phenomena (e.g., earthquake distribution, volcano distribution, crustal temperature distribution, air temperature distribution, etc.). The task for this activity is focused on making observations and recognizing patterns, two very important science skills and, though the Earth Science data is unfamiliar, these two activities are very 'do-able' by most students.

Anecdotal data and reports from student portfolios suggest that these and similar activities attend to the affective domain in several ways: 1- for Do You Know Me?, every student has experiences related to this illustration of the scientific process and therefore it is easy and non-threatening to be included in the activity; 2- Do You Know Me? also results in a higher comfort level between the students and instructor; 3- every student has some success in making observations and formulating inferences during the open-ended Earth Observation Day activity; 4- activities such as these set a positive tone for the class because the students feel successful having completed the activities while gaining insight into the process and skills of science, which improves their outlook on and interest in the rest of the course.

KATHIE OWENS, CURRICULAR AND INSTRUCTIONAL STUDIES, UNIVERSITY OF AKRON

ESSAY: TEACHERS' SELF-EFFICACY

I am a teacher-educator who collaborates with geoscience faculty members at the University of Akron on teaching, learning, and assessing initiatives. Much of our joint work rests in the cognitive domain, although in the affective domain, we have looked at students' attitudes towards science and the geosciences and their satisfaction with the active class pedagogy (attendance, retention, participation).

Each summer I conduct a workshop on science and technology for elementary school and middle school teachers. Our goals are to increase teachers' science content knowledge, to impact their self-efficacy (confidence) as science teachers, and to lower their concerns regarding making changes to their teaching practice. To measure the second and third goals we use a pre-, post-, and delayed post- test design. Over the past three summers we have seen encouraging gains in teachers' self-efficacy and their concerns about teaching standards-related content by inquiry methods have diminished. We have inferred that these gains derive from both the teachers' increased content knowledge and the pedagogy we employ in the conduct of the workshop. "Traditional" science courses whose methods rely on lecture may have a negative impact on teachers' self-efficacy. When teachers know well the content they are required to teach and they have learned this content by methods they can employ in their classrooms, their efficacy improves, they teach more science and their students learn more.

Most of my work focuses on preservice science teacher preparation and I am interested in their self-efficacy as a factor of their effectiveness in their future classrooms. According to Ashton & Webb (1986) experiences in future teachers' undergraduate courses (all their courses, not just their education courses or student teaching) affect their sense of efficacy. A teacher's poor sense of efficacy often results ineffective learning experiences for their students. Since preservice teachers take geoscience courses, I am interested in the impact on their self-efficacy of their learning experiences in their geoscience classes. Since self-efficacy is domain specific (Bandura, 1977), I cannot assume that when my students leave my methods class with a strong belief that they can teach science that this belief encompasses teaching earth science.

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DEXTER PERKINS, GEOLOGY, UNIVERSITY OF NORTH DAKOTA
ESSAY: THE AFFECTIVE DOMAIN AND COLLEGE STUDENTS

There are many reasons why I think college teachers (and their students) should think about the affective domain. Below is a summary of some significant problems/conundrums that I have encountered that, I believe, fall into that domain: Sometimes students are just not ready to receive/learn information. If students are to learn, they must be willing to learn. They must be willing to listen to instructors with respect, to read and appreciate what they hear and read, and in other ways to recognize and value authority. Unfortunately, students are not always this way.

For maximum learning, students must be active participants in the learning process. They must attend class, they must participate in class, and they must put effort into participation. They must be motivated. Frequently, in recent years, I have found students who are unwilling to do one or all of these things. Students must have values that they bring to the classroom. For example, they must recognize the value of seeking truth. They must understand why knowledge is good (to quote Animal House). They must value problem-solving skills. They must recognize the value of getting actively involved. And, their values must be reflected in the way they approach their education. I am not sure, but I think a lack of values may be a problem with some college students. Perhaps it relates to maturity, or perhaps it has another origin.

Students must organize their ideas and place them into a context with all the other things going on around them. They must be organize their lives, balancing school-, job-, play-time. They must set priorities, deciding which activities to focus on when and their commitment to each. They must decide the direction of their lives, the pace they will take, and (ultimately) where they want to end up. This relates directly to values (above) but also involves many other things. Lack of organization of this sort is a major problem with many students.

Finally, students need to strive toward balanced lives. They need to balance their practices, schedules, behavior and goals. They need to develop consistent social, emotional and personal schemas to guide them through their lives. This development is ongoing – throughout an entire lifetime – but it depends on good habits and thought processes that we should reinforce while students are in our classrooms.

ERIC PYLE, GEOLOGY & ENVIRONMENTAL SCIENCE, JAMES MADISON UNIVERSITY
ESSAY: "JUST MOTIVATE THEM" FOR GEOSCIENCE INQUIRY

When I was a high school science teacher in the 1980s and 90s, the principal that felt that the solution to my students not making up labs and quizzes missed due sporting events was to, "Just motivate them." He had little to offer me in terms of motivational strategies beyond, "Just embarrass them." One of the first questions that I faced was what does a motivated student look like in terms that could be defined and generative of diagnostic instrumentation. A potential outcome of my inquiries would the definition of instructional strategies and organizational frameworks that could be shared with other teachers. In this manner, they could create learning environments that would promote student effort through motivation rather than more punitive approaches.

I could reasonably assume that student and parent groups that visited informal science education environments of their own volition, that is, not part of a school group or other compulsory grouping, were motivated to engage in science. Under this assumption, the venue was a free-choice learning environment, where the primary motivating factors were intrinsic to the students and their parents, rather than extrinsic from a curricular requirement. From an analysis of interview, videotape, and observational data in 3 museums and 3 science-oriented stores, several variables related to students' social cognition, motivation and action, and evaluation were isolated:

Intrinsic to the student

- Relatedness – the extent to which students need and utilize peer learners in a given situation;
- Autonomy – the extent to which students perceive personal agency in the selection of tasks and approaches to tasks;
- Competence – the extent to which students believe they have mastered a task;

Intrinsic to the social context of the student

- Connectedness – the relationship of the student to more capable peers;
- Autonomy Support – the extent to which students perceive that their choices are supported by more capable peers;
- Effectance – the extent to which students believe that they could change the outcome of a situation or task, should circumstances require it.

Through the articulation of these variables, a quantitative instrument that assessed students' responses to learning environments with a high degree of reliability was developed and field-tested. Given the content specificity of the students' responses, it was clear that sets of questions related to a broader set of situations was needed. What remained elusive, however, was the direct implementation of the findings on all six variables in a given classroom setting. I have been able to utilize individual aspects of the variables in various settings, from small graduate level classes to large undergraduate introductory geology classes, but a consistent, situation-specific setting has been needed to realize the more consistent application of strategies in my teaching, based at least in part on the characteristics of a given cohort of students.

My current interests lie in the synthesis of inquiry-oriented pedagogies specific to the geosciences, as informed by measurements of the motivational variables described above in large introductory geology classes, teacher professional development sessions, and secondary Earth science classrooms. An application of these motivational variables in geoscience education, through inquiry instruction, has the potential to impact recruitment, retention, persistence, and above all, learning in the geosciences at multiple levels.

KELLY ROCCA, ST. JOHN'S COLLEGE OF LIBERAL ARTS AND SCIENCES, ST. JOHN'S UNIVERSITY

ESSAY: THE AFFECTIVE DOMAIN OF LEARNING: NONVERBAL IMMEDIACY

A commonly researched area in the field of instructional communication, impacting affect between teachers and students is a construct defined by Mehrabian (1971) called "immediacy." This concept, which has been researched extensively in the instructional communication literature in the past 30 years (for a summary of the research in this area, see McCroskey & Richmond, 1992 and Richmond, Lane, & McCroskey, 2006) is defined in terms of Mehrabian's "principle of immediacy" which states "people are drawn toward persons and things they like, evaluate highly, and prefer; and they avoid or move away from things they dislike, evaluate negatively, or do not prefer" (Mehrabian, 1971, p.1). The overall theme in the research is that immediacy is a positive attribute for professors to engage in when it comes to the affect in the classroom. Nonverbally immediate behaviors include the following: gesturing, speaking without a desk/podium, moving around the classroom, eye contact, appropriate gestures, appropriate touch, smiling at students, and using vocal variety (Thomas, Richmond, & McCroskey, 1994). Professors who are higher in these areas are rated as higher in immediacy by their students, and higher levels of immediacy are related to a number of positive affective areas with students, as shown in empirical research, and as evidenced in classroom observations as well.

Early studies very quickly linked immediate behaviors with student affective learning (e.g., Andersen, 1978; 1979; Kearney, Plax, Smith, & Sorensen, 1988; Kearney, Plax, & Wandt-Wesco, 1985; Plax, Kearney, McCroskey, & Richmond, 1986; Witt & Wheeless, 2001). Recently, a meta-analysis on teacher immediacy and student learning was conducted which included 81 studies from 1979-2001 (Witt, Wheeless, & Allen, 2004). These studies found teacher immediacy to be associated with positive student affect (liking of the teacher, liking of the subject matter) as well as increased cognitive learning and more positive student evaluations of immediate teachers.

Richmond (1990) also found that teachers who were nonverbally immediate and used prosocial (i.e., asking nicely) means of gaining compliance had much greater affect with their students than those who used antisocial (i.e., verbal aggression) methods of compliance gaining. Teachers who are immediate have students who have greater affect for them (e.g., Chesebro, 2003; Gorham, 1988), have higher motivation levels (Christophel, 1990; Christophel & Gorham, 1995), and are more likely to attend (Rocca, 2004) and participate (Rocca, 2001) in class than students with non-immediate teachers.
There are numerous means by which professors can increase students' affect in the classroom, both for the subject matter and for the professor. Nonverbal immediacy is one of those methods, one which is linked to many other positive affective behaviors in the classroom.

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PAUL RUSCHER, METEOROLOGY, THE FLORIDA STATE UNIVERSITY
ESSAY: TEACHING ISOPLETHS

In 1996, I inherited the teaching and ultimately coordination of the introductory meteorology laboratory course for non-science majors at FSU from a retiring colleague. In that time, the class has grown to ten sections per semester, taught to over 500 students per academic year, taught primarily by first-year graduate students, some new to the field of meteorology (and teaching!). And it has been completely transformed by my predecessor's efforts as well as my own efforts, some of which have been adopted through fits and starts.

One of the most transforming moments for me as an educator came when I attended the Cutting Edge workshop for Geoscience Educators entitled Designing Effective and Innovative Courses in the Geosciences in the summer of 2004. I went into this workshop looking for ways to get students more interested and engaged in practical labs that would be more informative for them. The class is, after all, a liberal studies science elective designed to engage students in the process of scientific discovery. But we had been failing miserably at maintaining student interest and engagement through the two hour sessions. So I was looking forward to designing new experiences for the students that would help to maintain their interest.

A big struggle for me was the teaching of isopleth analysis, a fundamental right of passage for any geoscience major, and something which we forced our students to learn, by rule, over a grueling three week period. I've devised a strategy for accomplishing what I think might be a more reasoned approach, but I was challenged at the 2004 workshop (by either Heather M. or Barbara T., I think) to consider an option of not teaching isopleths at all! Heresy! I came back to Tallahassee and came up with an alternative that seems to make sense, and it is published in my lab manual (Ruscher and Stephens 2005) as Lab #10. The lab still takes two weeks to complete in its entirety, but takes far less intense instruction, thanks in large part to its reliance on an online simulation (Ackerman and Whitaker 1997). And students seem to be interested by the telling of the story of an evolving coastal snowstorm, which was a surprise to forecasters (January 2000). But I still wonder about the heretical suggestion and its potential consequences.

My own motivation for teaching isopleths lies in the expectation that students in meteorology (and across the geosciences) are faced with interpreting spatial patterns based on black and white line drawings or colorful images and visualizations full of isopleths and contours, the subtleties of which are often lost upon them. My hope is that we can teach students not only what the lines and colors mean, but we can also help them to understand some of the information content embedded behind them. As GIS and Google Map applications proliferate in our classrooms, are we sure that our students really understand what is being shown? Is the teaching of isopleth analysis necessary?

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STEVEN SEMKEN, SCHOOL OF EARTH AND SPACE EXPLORATION, ARIZONA STATE UNIVERSITY

ESSAY: SENSE OF PLACE IN GEOSCIENCE TEACHING AND LEARNING

Geoscience educators teach in and by means of places: localities imbued with meaning by human experience. The human connection to places is often described as a "sense of place" that combines intellectual meanings and emotional attachments, and thus bridges the cognitive and affective domains. Some underrepresented student groups with strong cultural and economic ties to land and environment (e.g., American Indians and Mexican Americans in the Southwest) may be dissuaded by geoscience teaching that conflicts with their senses of place (sometimes expressed as a kinship). Place-based (PB) methods actively leverage sense of place (including attachment) and may better engage such students.

My interest in this field began with qualitative studies of Navajo scientific knowledge and teaching methods to inform the design of PB geoscience courses. Since moving to ASU in 2003 I have worked with a more diverse student population, and large enough for quantitative research. My graduate students and I survey place attachment as one of several measures of PB teaching effectiveness. Our lab is a multicultural Southwest PB introductory course I have now offered twice ($n = 30$ and 220). We administer a valid, generalizable 12-item Likert survey of Southwest place attachment as pre- and post-tests (and in the most recent experiment, at the course midpoint), in tandem with validated quantitative surveys of place meaning and content knowledge, and qualitative surveys of student interest and satisfaction. The initial 30-student group showed significant ($p < 0.01$) mean increases in place attachment and the other measures. Linked qualitative surveys reported student enthusiasm for the culturally situated focus on regional Earth systems, among natives and newcomers alike. Multivariate analyses of possible correlations and predictive factors are underway. The work will be presented at the April 2007 NARST conference.

We have just extended this project to a group of ethnically (American Indian, Mexican American, Anglo) and professionally (STEM, history, sociology, English) mixed in-service teachers in the Superior copper mining district 100 km east of ASU. Working with ASU educational psychologists and statisticians, we are surveying a broader range of affective measures, including instrumentality (belief that the PB course will be of future benefit) and motivation. We are also helping validate a new survey of teacher attitudes toward STEM teaching. The experimental PB course includes a weekly "learning community" session in which attitudes toward place and pedagogy can be formatively tracked and cultural expertise shared.

For more information:

Semken, S., 2005, Sense of place and place-based introductory geoscience teaching for American Indian and Alaska Native undergraduates, Journal of Geoscience Education, v. 53, p. 148-157.

Laura Serpa, Geological Sciences, University of Texas at El Paso
Essay: Teaching an Introductory Geology Course over the Internet to Hurricane Katrina Victims

Until Fall 2006, I was on the faculty at the University of New Orleans (UNO. Thus, I was one of an immense number of people who were adversely affected by hurricane Katrina a week after classes at UNO had started. Fortunately for me and my students, UNO did not close but, because it was inaccessible for the Fall 2006 semester, they decided to offer courses over the internet. I was one of the many inexperienced faculty members who offered introductory internet classes to our displaced students. I had the good fortune to get permission from Dr. Debra Secord to use her well-designed internet course (dl.coastline.edu/classes/internet/geology100) as a basis for my class and I thought the rest would be easy. What I had not expected was the lack of cohesion that students have when taking an internet course. It is the exact opposite of taking a course where you can work in groups, learn from each other, or see your classmates struggle with concepts. Each student clearly felt they were the only member of the class and I was their private tutor. Add to that the fact that we were all victims of a monstrous disaster, found ourselves in impossible living conditions, and were struggling with all sorts of emotional issues. Many students had no homes, had lost family members, and were living in makeshift temporary shelters. They had very limited access to the internet, usually at a local library, to use for the class. It was rapidly clear that engaging students' interest was not going to be easy with a traditional class.

What I did was to make extensive use of the discussion capabilities of the internet system we were using (Blackboard) to keep a running dialogue between students about the disaster with a focus on the associated geological problems, possible solutions, and potential future problems. I posted questions each week and required the students write something but it was mainly self sustaining once the students learned to access the discussion board. We spent the first several lectures talking about the disaster as a scientific problem then went on to discussions about what might have been done to avoid some of the problems, future issues about rebuilding in the area, and finally about potential disasters elsewhere. Most of the classroom topics could be linked directly to the discussions.

I think there are many other things I could have done to make this a more effective learning experience but most of the students appeared to recognize that there are geological problems everywhere. The students are very likely to investigate hazards when they move to a new area and to insist that reasonable safety measures be taken to avoid future disasters. I feel that some of the students have developed a value complex that incorporates geoscience knowledge into their decision making process.

Suzanne M (Suki) Smaglik, Chemistry & Geology, Central Wyoming College
Essay: Can I pass this class if I don't "believe" in ... ? Motivations and Attitudes in Student Learning

For the past twelve years I have had a ten-percent portion of class grading based on "Attitude & Attendance (A&A)." My students laugh nervously at the title (I've tried a few; this one seems the most realistic), but it is the hardest part of the overall course grade that I assign each student at the end of the semester. Students earn points (mostly objective) for quizzes, labs and other assignments; I make a subjective decision as to their A&A. Ten percent can often be the difference between two letter grades. After writing this eassy, perhaps I'll change "A&A" to "M&A" (Motivation & Attitude).

In part, it is difficult for me to assign this portion of the grade because I AM an emotional person. Sometimes its hard for me to be a scientist, but perhaps this is part of the reason that I have been successful in teaching controversial topics in my courses. I understand the students need to be emotional about things that concern them personally. I allow discussion of these feelings in my classes for a short duration. However, I am careful not to let it distract from the learning of science. I ask them all to be skeptical, yet open-minded – the traits of a good scientist. As difficult as some of these discussions may be, they let me see into the students im/perceptions of the topics. There are a few interactions that have stayed with me as I have journeyed through the academic haze.

After a lecture/discussion on the origin of the Universe in a liberal arts physical science class for elementary education majors, a student approached me to discuss the "revelation" she had had during class. Patti was a fundamentalist Christian who was having a difficult time as an older student in a crop of "twenty-somethings." She was also having a hard time with the "age of the Earth." She made a connection, somehow, that all the stuff of the Universe was part of us as humans and that stars and other heavenly bodies where just another way to reincarnation (or heaven). "Maybe there is something to this science stuff, after all." Wow, what a connection! Although I could not acknowledge her religious connection, I was glad that she had finally found someway to relate to science. This event happened about one-third of the way through the course and she showed dramatic improvement of her understanding of physical concepts after her revelation.

My first try at teaching Historical Geology frightened me. It was not my area of expertise and I was very apprehensive about teaching evolution in an area where people believed strongly on the "truth of the Bible." I had a very small class (7 students) and the first day went particularly well. There was a very inquisitive young man, Brian, who asked wonderful questions. I was actually looking forward to having him as a leader in the class. Brian did not return to class the next period. Two weeks later he stopped by my office to discuss his dilemma – he really needed this course to graduate that semester, but he couldn't stomach what he had read in the first chapter of the text. "I disagree with everything it says" he exclaimed. I invited Brian to sit down and discuss his feelings. I explained my position as a scientist and a teacher, and reassured him that he did not have to change his religious views in order to pass the class. I asked Brian only to be receptive to the scientific concepts and their explanations as presented in the course. He decided he would try it since he really needed the lab science credit. Brian became the best student in the class. Although his questions challenged me, they also showed me that he was really motivated about what he was learning. After the course was over, Brain came to me and told me "I understand why scientists would think Earth was older than 6,000 years; it must have taken along time for all those rocks to build up and change. Thank you for asking me to stay in the course." I have had many similar experiences since that time and Historical Geology has become one of my favorite courses to teach. In fact, the title of this essay comes from a student who took this course and got an A.

My next challenge occurs in the upcoming semester. I will be teaching for the first time, a sophomore-level course on Earth System Science which has an emphasis on global change. I've already had two of the six registered students tell me that global warming is just part of the natural cycle and there is nothing we can or should do about it. I'm looking forward to this class enormously.

LEEANN SROGI, GEOLOGY & ASTRONOMY, WEST CHESTER UNIVERSITY

ESSAY: COOPERATIVE LEARNING AND INSTITUTIONAL GOALS FOR STUDENT DEVELOPMENT

The affective domain is critical in defining institutional-level goals for student development. The Assistant VP for Student Affairs at my university listed our goals as: Intellectual Development (reasoning, critical thinking); Identity Development (autonomy, integrity, sense of self); Interpersonal Development (socialization, respecting others); Values Development (role in society, acts based on values, respecting rights of others). How I teach is an important part of meeting my university's goals. Research in cooperative learning (e.g., Johnson et al., 1996) indicates that positive peer relationships are essential to success in school and help students learn, that isolation and alienation are predictors of failure; thus, cooperative interaction connects the affective and cognitive domains.

I have been using cooperative exams for mineral identification since 1991, and began to survey students to assess the cooperative exams in 2004-05. Cooperative exams are more than "can you identify the correct mineral." By emphasizing diagnostic properties and hypothesis testing, exams help build skills in critical thinking and reasoning from evidence. Students must defend their observations and conclusions to their peers, and develop confidence in their process of identification. Cooperative exams promote a positive learning environment as students work together, learning to listen to and respect others' opinions. The "no mooching" policy helps students toward the recognition that it's not about what others can provide them, but what learning can be achieved for all when everyone participates. Cooperative exam goals related to the affective domain include: that students will increase knowledge sharing, build community, gain insight into what they know and how they know it, and develop confidence and a sense of personal authority about their knowledge. Preliminary results from the quantitative data show that cooperation during the exam is important: students test mineral properties, listen to others' ideas, ask questions, and propose their own ideas more during the cooperative exam than when studying together. They report greater confidence in knowledge, inquiry, and communication when they take the exam together, particularly in justifying their ideas with evidence. Students' responses to open-ended questions are more variable. I plan to analyze the responses using a framework related to the affective domain (e.g., Krathwohl et al., 1964), and hope to share results at the workshop, and discuss methods of assessing goals in the affective domain.

Although not rigorously assessed, I find that an identification activity with assigned roles is key to building positive interdependence among students before the exams. I observe students' behaviors in the first week and then assign groups and a specific role to each group member for the mineral identification activity. The people who did not handle the materials or speak out much initially become the tester/presenters, actively testing the mineral properties and then reporting out to the class. The people who were most active and vocal become the recorders, and practice listening to the testers and the fact-checkers. In semesters when I did NOT structure these activities and assign roles, it seemed to take longer for equitable participation in the groups to become established, such as sharing materials, listening to all viewpoints, and soliciting and answering questions. Used judiciously, more structured learning activities may have benefits for student learning goals in the affective domain.

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ESSAY: THE CONSEQUENCE OF RELEVANCE ON STUDENT ATTITUDES

A student's attitude and perception of science is often opposite of those held by expert and can have a significant affect on student performance in the classroom (Songer & Linn, 1991). While investigating student attitudes regarding introductory physical geology classes at a large state university, preliminary interviews of 13 students from a variety of science and non-science majors revealed that level of interest correlates with the overall performance in the class. When asked what determines level of interest and attitude toward a class the most common responses can be classified as (1) relevance to their future (e.g. career, major, where they want to live) and (2) relevance to their current or past experiences. Pre-semester student questionnaires suggest a strong initial interest in geology based on students past experiences such as visiting national parks, where they live or go to school, visiting natural history museums and positive earth sciences classes in K-12.

This information seems encouraging as many geoscientists say confidently that it is easy to show the relevance of geology to people's everyday lives, for example oil prices, environmental concerns, and natural resources. Unfortunately there appears to be a breakdown in communicating the relevance of geological and earth systems science to everyday life to "non-geologists" in introductory classes. When introductory students were asked halfway through the semester if the material presented in class was relevant to their lives, nine out of 13 students responded negatively. Students perceived that most of the material in an introductory geology class was not relevant because the material was (a) to detail-oriented and (b) had to be memorized. In addition, student interest in geology decreased over the course of the semester due to the perception that memorization, not critical thinking, is necessary in order to succeed in geology. Students are missing geology's big picture, the relevance of geology to their own lives, and as a result appear to develop a negative attitude towards geology. While these are preliminary results, it is a cause for concern that students attitudes appear to change from positive to negative as negative attitudes will hinder student learning in the classroom as well as use of that material outside of the classroom (Gal & Ginsburg 1994).

The apparent results of negative attitudes in learning are antagonistic to an instructors' goal to have the student develop an appreciation of the subject at hand and it would be in the best interest to consider students attitudes and interest levels when developing course material. Education research have suggested numerous ways how to promote positive student attitudes in science and mathematics classrooms such as presenting motivational topics in the beginning of course (Moore, 1997), the use of hand-on inquiry (Ornstein, 2006) , and the use of learning goals to focus on conceptual learning (Perkins et al., 2004). While these approaches may work in other science and math classrooms, the unique composition of an introductory class, in which approximately 50% of student being non-science majors and often less than 20% geology majors, may mean that new approaches need to be considered. Classroom observations and student interviews regarding introductory geology classes suggest the potential of approaches such as (1) if questions, both in-lecture and assignments, are phrased to the student's vocabulary, (2) use of local geography or areas familiar to student as geological examples, and (3) use of current events in lecture. However the effectiveness of such approaches to promote positive student attitudes and geological concepts has still yet to be determined in large introductory geology classes.

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LENSYL URBANO, EARTH SCIENCES, UNIVERSITY OF MEMPHIS

ESSAY: VOICES AND LANGUAGE

I grew up on a small island in the Caribbean, completed undergraduate and graduate degrees in New York and Minnesota, and now teach at a school in the southern US. Because I grew up speaking English, it took me a while to realize that I do not speak the same language as my students. Much of my teaching philosophy and method has been driven by the need to overcome this divide, particularly by allowing and facilitating students' creation of educational media (text, audio narration and video) for my classes. It has been students'

response to seeing and especially hearing the voices of their peers enunciating scientific concepts that has lead me to realize the potential power of peer-produced media in tapping the affective domain.
Quite apart from cadences of speech, language is full of the cultural constructs and idioms that can assign different meanings to the same words. From this perspective, teaching introductory Geoscience classes involves introducing students to the language and culture of science, and the challenge becomes finding a shared semiotic space where students and instructor can communicate effectively. To get there effectively students need to learn some of the language of science and instructors need to learn some of the language of the students. But in the large (150 students) introductory classes I teach, students come from diverse backgrounds and there are a multitude of cultural groups with their own variants on language (call them literacy groups). It is by harnessing this diversity that collaborative projects work so well. Student group discussions expose each individual to multiple perspectives on the topic, which for less experienced students increases the probability that each individual is exposed to the concept with idioms they understand, and exposes each individual to multiple perspectives that broaden their range of language.

Yet why restrict the benefits of collaborative learning to ad-hoc groupings that last a classroom session or even a semester? If multiple uses of language aids learning, why not record those uses and make them available to peers? This is a major part of my teaching philosophy. To this end I have used Wiki style websites for students to write and narrate (audio) their term projects, and developed technology (eg. the MovieClassroom) to facilitate students' creation of educational movies. For all of these projects, students are told that their grade depends partly on the specific utility of their project to help other students learn the material. There are significant educational benefits that accrue to the students creating and explaining geoscience concepts. However, most pertinent to this application are the potential benefits for users of this material.

As students have produced reliable material, I have been incorporating them in lectures and readings. Short movies shown in class have elicited the most interesting response. A large majority of students say they would like to see more of these during class (primarily because it provides a good break) and posted to the website (so they can view them again). However, there are significant differences in their perceptions of the movies' educational utility, as well as, their "entertainment value". I am currently trying to design surveys to determine if actual (as well as perceived) learning is a function of the students' enjoyment of the movies, and what parameters determine enjoyment. These are fundamental questions regarding the affective response, however since I am new to the field of education research, I am extremely interested in learning more about the role of the affective domain in geoscience learning.

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TATIANA VISLOVA, EARTH SCIENCES, SUNY COLLEGE AT ONEONTA
ESSAY: ADDRESSING THE STUDENTS' GOALS

This fall I taught an Earth Materials course to students majoring in Adolescence Education with a concentration in the Earth Science. This new course was created in order to provide education majors with a shorter and simpler version of traditional Mineralogy/Petrology sequence available for geology majors. When designing this new course I had a very clear set of goals related to the cognitive domain: what knowledge I wanted my students to gain and what skills to master. I wanted them to be able to identify minerals and rocks, to explain where and how they usually form (geological setting and geological processes), and to describe their economic and environmental significance.

This class obviously included lots of practice with mineral and rock samples, as well as memorization of their names and properties. Only few people are naturally fascinated by the beauty of rocks and minerals, and are curious about how they form. So in preparation for this class I was searching for a way to motivate all my students. I was asking myself a question: what would I like to get from this class if I were planning to become a high school teacher? I came up with the following: ideally I would like to put together my own unique teaching portfolio including in-class and field exercises, lectures, and labs. It would be also great to start my own rock and mineral collection. And as a future teacher I would like to get some experience with using technology (website, posters, and power point presentations).

It was important for me to understand that students came to my class not to get the good grades, and even not to become good in identifying minerals and understanding the geological processes, but to receive a good preparation for their future successful careers in teaching. Once I formulated this purpose of the course for myself it was easier for me to build a curriculum including affective domain categories (receiving, responding, valuing, organization). Instead of memorizing the minerals students were thinking of how to help their future students to do it. Instead of going on the fieldtrip, students were designing and leading the fieldtrips. They were encouraged to evaluate themselves, each other, and me, exchange ideas and explore. Whatever activity I was using in class I always draw their attention to content, resources, and teaching methods I were using.

Following are examples of some individual and group activities we did in class:

- Groups of students were asked to explore on their own the campus area searching for earth materials used as building or decorative stone, write down the "guide to the geology of the campus", and finally lead the campus tour for the rest of the class.

- Students were asked to explored USGS website on volcanic hazards at home and come up with the questions for the quiz. I put together the quiz made of their questions, and students were graded for the quiz itself and for the quality of their questions as well.

- We constructed the concepts map for the course as a whole class discussion.

It was very rewarding for me to see students getting excited about topics we were covering, producing great ideas, and evaluating sources. Another very strong advantage of this approach was an atmosphere of respect in the classroom. I felt like I was sharing my knowledge and teaching methods with colleagues, and based on students evaluations students truly appreciated that.

Other ideas, which I am planning to incorporate in the future, include designing students' unique hands on projects (demonstrating volcanoes, earthquakes, etc.); mock school students teaching of earth materials; constructing a website; competition on "the best website on mineral properties"; putting together actual individual teaching portfolio for each student.

AL WERNER, DEPARTMENT OF EARTH AND ENVIRONMENT, MOUNT HOLYOKE COLLEGE

ESSAY: I'M NO GOOD AT SCIENCE!

Many students come to college confident in their belief that they are no-good at science. Perhaps they had a bad experience in a middle or high school science class, perhaps they don't have particular strengths in science and math or worse, perhaps they have been encouraged away from the sciences or have learned that being too clever in math and science classes is unattractive (especially for young women). Whatever the reason, many students find themselves in a required science distribution course and in many cases this is an intro geology course (because chemistry, physics and biology are considered "harder" and more quantitative). This one required science course may be the only science course that a student will take during her college career and it is in this course that they will learn science material, learn how to think scientifically and most importantly, solidify their perspectives of science and scientists. In short, this one required science course can greatly influence their understanding of how science works, their perspective of scientists, and their understanding of the role of science in everyday life. Even if we don't make scientists of these science-phobic students, we need them to understand science and to appreciate the value science – at very least we don't want to validate their "I can't do science" ideas.

Introductory geology courses can be very effective at breaking down these "I can't do science" walls because most students can personally relate to the material covered in intro. geology courses and because this material (e.g. earthquakes, flooding, climate change etc.) is timely and constantly in the news. These personal connections and the timeliness of the material are important in-roads for student engagement and can facilitate science thinking and quantification. At Mount Holyoke College we have developed intro labs that give students a taste of what it is like to work as a geologist by having students work on real-life problems in the lab component of the course. For example, we require them to determine the discharge or the campus stream by measuring water depth and velocity across the channel, we ask them to find the best place in the local area for a new landfill and we ask them to determine the source, direction of ground water flow and extent of contamination of a leaky underground storage tank on campus. In these labs we give them reasons to need to be quantitative and to think scientifically.

Scientists are often perceived as indecisive and contradictory and therefore it has become easy for officials, politicians and the media to dismiss scientific perspectives. This of course comes from the fact that science is full of theories and different possible interpretations and in fact this is how we (and why we) continue to test our hypotheses and eventually move closer to the truth. Unfortunately, this approach is often viewed as "wishy-washy" and unsatisfying to those who want (demand) definitive answers. I believe that we need to teach the scientific method in our intro. courses, we need get students familiar and comfortable with evaluating all of the information and then we need to debate the merits of various interpretations/actions. For example, everyone who has determined the 100 year flood zone for a river knows that it is often based on a limited understanding of past river behavior – yet it is considered one of the best ways to determine the magnitude and the recurrence interval of river flooding. Similarly, the climate change debate is complicated and confusing but students must understand this complexity as best as they can and realize that just because an issue is complicated (and there are conflicting perspectives) doesn't mean that the scientific perspective should be dismissed.

Introductory geology courses are great vehicles for engaging students in science because they are timely and student already have a connection with many of the topics discussed. Investigations and quantification in the lab can often break-down the "I can't do science" barriers and discussions in lecture need to provide students with an understanding of how science works. For many (most) students this will be the only science course they will take in college and we need to teach more than geologic concepts and terms.

KARL WIRTH, GEOLOGY, MACALESTER COLLEGE
ESSAY: THINKING ABOUT LEARNING: MOTIVATING STUDENTS TO DEVELOP INTO INTENTIONAL LEARNERS

After attending the Teaching Mineralogy Workshop in 1996 I returned to campus excited about the many ideas for new hands-on activities. I was convinced that active learning was a better approach to teaching and

I couldn't wait for the fall semester to begin. My enthusiasm was dampened somewhat by the rather lukewarm reaction of some students to my first attempts at creating learner-centered courses. Some students were openly skeptical of these new learning experiences; others were reluctant to embrace the course goals for deeper learning. I was baffled and disheartened.

My early experiences with active learning started me thinking about how to help students adjust to new instructional methods. Initially I began talking with students about the results of research on learning, instructional design, and assessment. The goal of these early conversations was to help students understand the reasons for implementing new pedagogies. In particular, problem-based and collaborative learning can present unique challenges, so I wanted to acknowledge to students that these new approaches could sometimes seem daunting. Importantly, I also wanted to share with my students the excitement that I was experiencing as I learned about teaching and learning. Student concerns about new instructional methods were significantly reduced by these conversations, but it still felt like these early attempts at talking about teaching and learning had little effect on their attitudes or motivations about learning.

Over the next several years I also gradually came to realize that if helping students develop their skills for thinking and learning is an important goal of higher education, then our curricula should address these objectives more explicitly. A recent report by the AAC&U (2002) advocates greater emphasis on educating students to be "intentional learners" who are purposeful and self-directing, empowered through intellectual and practical skills, informed by knowledge and ways of knowing, and responsible for personal actions and civic values. Self-directing learners also take initiative to diagnose their learning needs, they formulate learning goals, they select and implement learning strategies, and they evaluate their learning outcomes. It is commonly assumed that students will develop these sorts of skills, motivations, and attitudes in the course of mastering content, but this is not necessarily the case. In an effort to help students develop these skills, I began introducing a learning co-curriculum into my courses. Developing this curriculum included writing an overview about learning, designing new classroom activities, and incorporating discussions and reflections about learning in all of my courses. These activities not only provide a foundation for developing skills for life-long learning, they also provide scaffolding as students undertake greater responsibility for their own learning. Additionally, students now have a shared vocabulary about thinking and learning, they have a clearer understanding of my expectations for their learning (i.e., that student learning goals should go far beyond memorizing content), and they are more intentional about their own learning. Student motivations and attitudes have changed remarkably with the greater focus on thinking and learning in my courses. Furthermore, students more fully understand the value of their learning and their own development.

TODD ZAKRAJSEK, FACULTY CENTER FOR INNOVATIVE TEACHING, CENTRAL MICHIGAN UNIVERSITY
ESSAY: REDUCING FEAR AND INCREASING COMMITMENT IN AN INTRODUCTORY COURSE

Two of the most persistent issues I have faced in over 20 years of teaching is overcoming inherent fear for the course material and having students accept the course components (exams, papers, reports, etc.).
Fear is a debilitating factor and is amazingly effective in shutting down essentially all learning. As much as I tried to reassure individuals that the course would not be as difficult as they expected, I could not move several of the students in any given class to a zone of comfort. I noted on the first day of class students were flipping though the text becoming paralyzed by complex issues and procedures in "Chapter 17." I know the first thing I used to do when I purchased a textbook was to look through the text to see what I would be learning. If later chapters "looked" really hard I expected the course to be very difficult. This is fine for some students, but others are simply paralyzed by the fear they will not be able to grasp those very difficult aspects of the material.

I then tried something that seemed counterintuitive. A few years ago I started something I continue to this very day. On the first day of class I ask everyone to turn to a specific page toward the end of the text and give them a passage to read that is very difficult. I then ask for a volunteer to explain the material. Faced with blank stares, which is what I want, I give a big sigh of relief and tell them it is good to know they are in the right class. If they could already do the stuff at the end of the book, I would have nothing to "teach" them. I then ask them to turn to page one of the text, which has some very basic explanatory text. I give the class a few minutes to read a designated passage on that page and ask if anyone can explain in their own words what that means. I get many hands in the air and the mood of the class changes immediately. I conclude by pointing out that we will work toward and understanding of difficult concepts, as that is what education is all about.

On that first day of class I also have students develop the syllabus for the course. I tell them only two conditions must be satisfied. Whatever is developed must be fair to the group as a whole and that the end result must allow me to give them a legitimate grade for the course. I have done this for several years and it always works well. The students select number of exams, type of exams, papers, homework, attendance, and all other aspects of the course, including dates for each of the components. If anyone suggests 90% of the grade be attendance, I simply invoke rule #2 and indicate that such an arrangement certainly wouldn't allow me to assign a course grade on what they have learned.

Both of these "activities" are designed to address the fear students feel in a course they fear. I want students to be concerned about the material and the course, but not to be paralyzed by it. One result of these activities, and a few others in the course, is that student success rate is very high and I tend to get students who have not been successful in the past in my sections and they tend to do quite well. I have also shared my course materials with my colleagues, who have indicated they were surprised by the extent of material we cover in the course and the speed at which we successfully cover some of the more difficult concepts.