The American Geophysical Union and Two-Year Colleges

Bethany Adamec, Education and Outreach Coordinator, American Geophysical Union

The American Geophysical Union is a not-for-profit society of Earth and space scientists with more than 62,000 members in 148 countries. Established in 1919 and headquartered in Washington, D.C., AGU advances the Earth and space sciences through its scholarly publications, meetings, and outreach programs.

AGU Education offers a variety of special programs for Earth and space scientists, students, K-12 educators, and the public at AGU's fall meeting held each December in San Francisco, CA. The meeting attracts over 23,000 professionals annually and is the world's largest gathering of Earth and space scientists. Our goals include strengthening professional development of K-12 teachers of Earth and space science, contributing to strengthening Earth and Space sciences departments and undergraduate teaching at the college and university level, providing opportunities for interested AGU members to participate in outreach activities and programs, supporting national STEM education initiatives, and strengthening the numbers and diversity of the Earth and space science workforce. AGU has a particular interest in developing the talent pool of future Earth and space science professionals, and in efforts that engage and retain undergraduates, especially two-year college students.

The Unique Research Experiences for two-year College faculty And Students (URECAS) planning workshop was the AGU's first step in implementing a larger program focused on engaging and retaining two-year-college students in the Earth and space sciences. Research in the field of undergraduate teaching and learning shows that engaging in research can help students at two-year institutions succeed, thus our efforts have focused on fostering research by students.

The NSF-funded URECAS workshop was held in July, 2012 at the AGU headquarters. Participants included faculty from two-year and four-year colleges, as well as representatives from federal and state agencies and other professional organizations. Throughout the two-day workshop, presentations and small-group discussions tackled issues such as challenges faced by students and faculty who are involved in undergraduate research, best practices in conducting and institutionalizing research at two-year colleges, facilitating the transfer of research students to a four-year institution, and addressing the needs of diverse students. In addition to the discussions held among faculty members, representatives from federal agencies, professional societies, and undergraduate education organizations joined the conversation and provided information about tools and opportunities available at their institutions for both faculty and students. For more information about the workshop content, including the final workshop report, see http://urecas.agu.org/.

AGU is now working on the next steps for URECAS, with a focus on keeping students engaged in Earth and space science research and facilitating their transfer to four-year institutions. This takes the shape of special programming at the Fall Meeting for both students and faculty, and of staying engaged with the two-year college faculty community throughout the year, in addition to staying up-to-date with current research concerning two year colleges, so that AGU can leverage its size and reach to help the next generation of Earth and space scientists succeed. Visit the above website in the near future to learn more about specific efforts. We look forward to the opportunity to learn from other workshop participants about their current best practices and challenges in supporting two-year college students, and to building our network of those working to improve two-year college student success.

June 2013

Erica Barrow
Associate Professor
Ivy Tech Community College
Indianapolis, IN

Real-World Motivation

I am excited to attend this year's workshop focusing on supporting 2YC geoscience student success. My name is Erica Barrow and I am in charge of Earth Science (SCIN 100) and Physical Science (SCIN 111) at Ivy Tech Community College in Indianapolis, IN. Ivy Tech is Indiana's only community college; the main campus in Indianapolis has current enrollments averaging 25,000 students per semester. I am the only full-time instructor in geoscience and oversee approximately 15 part-time adjuncts in my subjects. Earth Science and Physical Science are a part of the Associate of General Studies degree (LAS Division); Ivy Tech does not currently offer a specific degree in science or geoscience.

Earth Science is a lecture/laboratory course combining geology, meteorology, and oceanography. Most of the students taking Earth Science are enrolled to fulfill a required science elective within their major; therefore, incoming student knowledge and enthusiasm for science is relatively low. Fostering student success within geoscience is a constant challenge for me. The major strategies I employ to support student success within my classroom are to motivate students through real-world examples pertaining to students own lives and to utilize current events across the globe.

I have found that the strongest motivator for student success is to relate classroom material directly to student own lives. An example of a real-world assignment I assign that directly pertains to students is on home water sources and usage. Within Earth Science we spend several lectures and a lab working through the water cycle, surface water/ground water transport, etc. Following this in-class work, I have students investigate their own source of home drinking water via internet resources. Students track their own water throughout the municipal water supply, aquifer, surface water reservoir, water treatment plant etc. Many students understand the biological importance of water but have never really wondered where their tap water comes from or that it is a limited resource. Comments at the end of the semester show me that this assignment is one of the most memorable and impactful experiences for students.

Related to real-world discussions, another strategy I employ to enhance student success is to utilize current events (Earth Science related) from around the globe to expand student's global awareness. Each semester my students are required to write three essays summarizing and critiquing a current event article published in a recent scientific journal. Students choose their own article from a list of provided journals (the article must relate to specific topics we have covered within the three different units of the class). This assignment gives students the opportunity to investigate a topic that interests them in a deeper and more meaningful way. Students are also given the opportunity to present/discuss their findings with the class or in small-group interactions. This assignment also helps to introduce non-science majors to the various career options available within science and science-related fields.

I am looking forward to learning about other strategies for ensuring student success.

Pete Berquist
Assistant Professor & Geology Department Chair
Thomas Nelson Community College

Is Workforce Training The Critical Link To Get Students Engaged?

Teaching geology at a moderately-sized community college in southeast Virginia has taught me that most students coming into my classes 1) are there because they need to satisfy their lab-science/general education requirements, 2) perceive geology to be either "easier" or "more interesting" than physics, chemistry, or biology, and 3) really have no clue what geology is about. As the ever-optimistic instructor, I've forged ahead with my classes expecting that enthusiasm, dynamic and interactive lectures and labs, and attempting to use details to construct "the big-picture" would lead to the new generation of geoscientists. Increasingly, I've learned that my students want to see connections to "the real world" and that they have little to no concept of what geoscientists "do". As I've started incorporating more real-world examples into my classes, I have heard more and more to the effect of "yeah it's interesting, but what am I going to do with geology?". Apparently a meaningful barrier still exists for my students studying the geosciences in more detail, and it seems that stronger connections to the workforce could help elucidate what geologists actually "do", providing my students with more relevant examples of geology and that critical link to what they could do after leaving my class.

Our Geology Department has employed several strategies to expose students to careers in geosciences. A few years ago, we started a "Jobs in Geosciences Lecture Series", which brought two professional geoscientists onto campus each semester. Our invited lecturers came from our personal network of friends and colleagues, and we had no issues finding folks willing to come to campus for a few hours. During each lecture, we asked our guests to talk about what they do in their jobs, what sort of technical and academic background they needed, and how they, personally, ended up in their current job. We received funding through our Educational Foundation to provide an honorarium to each speaker and to provide pizza and drinks for each lecture. Along with the lecture, we also scheduled an hour "meet & eat" with each guest, so that students had the opportunity to talk with each speaker in an informal setting and gain a more personal explanation about each professional's path. Survey data collected from students who participated in these programs demonstrated that our students greatly enjoyed these lectures, learned a lot, and desired for more opportunities like these.

More recently, we have tried to forge connections with local employers to explore any type of exposure to professional activities for our students. Establishing formal internships would be ideal, but financial and practical limitations with businesses and difficulty scheduling and training our students seem to be the biggest barriers. However, exploring opportunities for shadowing programs, informal internships, and meeting new professionals interested in contributing to our lecture series seem to be the most fruitful and immediate opportunities. Perhaps in the future, the relationships created with our local businesses could lead to a formal geo-technician certificate/training program, which would be unique within our state's assembly of community colleges. Overall, we feel that our existing program that provides students opportunities to do small-scale research projects, fieldwork, and work in small groups to communicate their science will become even more effective by strengthening the understanding of what geoscientists do in their respective day-to-day routines, teaching the skills and techniques commonly used by professionals and researchers alike, and developing more obvious partners within the workforce.

Engagement is my key to Student Success

Kristie Bradford, Associate Professor of Geology, Lone Star College – Tomball, Geology Department

Like many two-year colleges, my students form a diverse population. I have students from just out of high school to those nearer to retirement. Approximately a third of my students are the first generation in their family to attend college. A slim majority of my students are white, many are Latinos, a few are of Asian or African descent. The majority of my students work at least part-time; however, some work full-time. Many are parents. As a result, their educational experience is often quite challenging to them; and therefore, I must give them the greatest possible opportunity to learn in the classroom and to have a diverse approach to teaching each class.

In my experience, the best way to encourage students to learn is to make the class as interactive as possible. I try to limit the amount of time they are passively sitting and listening. I find that if I engage the students, they pay attention and learn more. To accomplish this engagement, instead of lecturing to the students, I tell them some information and then ask them questions to relate the new information to something they already know. By grounding the information and constantly checking for understanding, the content of the class becomes clearer. For example, when discussing the difference in viscosity between basaltic and rhyolitic lavas, I use the example of ketchup for basalt and peanut butter for rhyolite. I ask them to describe how each of the fluids would behave on an inclined plane. Then I get them to connect that behavior to the lavas. They quickly and easily recognize the difference and most do not forget it.

When introducing new topics, if I have hands on materials to illustrate the points, I will use them. For example: I have found that students struggle with the concept of clastic texture in sedimentary rocks and because we live on the Gulf Coastal Plain, there are no rock outcrops that students see with any regularity so their experience with rocks is often limited to pebble- and cobble-sized samples rather than outcrop-sized. As such, they have a hard time envisioning the relationship between a body of sand and a layer of sandstone. To assist, I place three bags of sediment (one of sand, one of silt/clay, and one of pebbles.) on each group's lab table. I also place a quartz sandstone, a siltstone, and a conglomerate on each table. By using the sediment samples and having the students match the sediment to the rock it will become they can better visualized and better understand clastic texture.

Fieldtrips are essential to student success in the geosciences. My students often comment that the fieldtrips really brought the material to life. I take my students on several fieldtrips locally during class-time and have optional fieldtrips on the weekends. By offering the out-of-class fieldtrips as extra credit, I have approximately one-quarter of my class attend. There is usually an observable difference in the depth of understanding of coastal process, for example, between a student who attended the Galveston Island State Park fieldtrip and one who did not. Fieldtrips also increase student curiosity as they are introduced to a world they never noticed before.

One of the greatest difficulties with the approach I use to cover new material is that it takes a long time. We cannot cover the quantity of content I used to when I lectured for 50 minutes and students quietly took notes. But, I have come to the conclusion that delivery of a vast amount of content to the students expecting them to absorb it all is neither necessary nor practical. My introductory classes are just that, introductory. It is my mission to get them outside noticing the world around them and making connections between that world and their lives. My goal is to introduce them to the major processes of the earth and through that introduction make them curious to learn more when they have a new experience with the out-of-doors or hear of something on the news long after they have left my classroom. Based on continued contact and the types of questions I receive from students who have completed the course, I believe that I do have some success with my approach to student learning.

Teaching Geoscience to Non-Science Majors: Using real-world examples and lecture worksheets

Marianne Caldwell, Geoscience Faculty, Hillsborough Community College

Teaching geology and earth science to my students can be a challenge, as typically only a few students are declared geoscience majors. Many non-science majors have had limited exposure to science in high school or experienced less than satisfactory outcomes in previous college science classes. Some students dread the class and feel science is just “too hard” to understand. In fact, I find a fair number of students delay taking their science classes until their final semester of their AA degree. Recognizing that students come to the class with a wide variety of levels and backgrounds, I have redesigned my classes to emphasize the application of geoscience to students’ everyday life. The goal of using this approach is to spark interest in the subject material by demonstrating its relevance to the student. Almost daily a geological event occurs somewhere in the world that can be a teaching tool. I utilize websites such as the USGS earthquake hazard monitoring site and the National Hurricane Center website; both provide real-time data along with maps. I also provide students learning activities specific to the region of Florida in which they live. Two examples are exercises involving groundwater depletion and flooding. The ultimate goal is to develop an informed citizenry that can recognize potential geologic hazards. The challenge of using current geologic events does require additional work. But the data is easily available online and many geologic events are documented by the news media. I have been able to gauge the effectiveness of this approach by seeing an increased student interest in these real-world events as a given semester progresses.

Another important change I have made is to modify the way I lecture in the face-to-face sections. Prior to the past few years, I would dutifully lecture the entire class period (one hour and fifteen minutes twice a week) assuming that the students were so enthralled by my vast knowledge of geology and entertaining colorful, picture-packed slideshow lectures that they just soaked up the material. Realizing that amount of time is too long for most students to concentrate and absorb the material, I modified my lectures to approximately forty-five minutes every class. During the last half hour of each class period, I now give students a worksheet that tests them on the materials covered in the preceding lecture. On the worksheets, I create figures similar to, but not exactly the same as, the text book or what was presented in lecture. I give full credit for completion and go over the more difficult answers the next class period. Although the worksheets are given a low point value, I have not had a problem with students working quickly and leaving early. In fact, the opposite happens, as most students now work diligently on the worksheets. During this time, I walk around the room to help any students that might need assistance. Although I have to move through lecture subject matter much more quickly than before, I do not feel I have sacrificed depth of learning. I require students to complete other assignments including review questions and computer-based review quizzes to cover subjects thoroughly. Implementation has required that I redo my class lectures to reflect the change in time available and prioritize the concepts. Because worksheets are used for every class, students have come to understand that being at lecture on time and attending each one is very important. Overall, I find that students like the format and become more enthusiastic learners. To test the effectiveness of this change in lecture delivery, I am planning to conduct a statistical analysis of student test scores before and after implementation, since I now have several years of data.

Websites: http://earthquake.usgs.gov/ and http://www.nhc.noaa.gov/

Local Rock Outcrop Project in Physical Geology & Historical Geology

Susan Howes Conrad
Associate Professor of Geology
Math, Physical & Computer Science Department
Dutchess Community College (Poughkeepsie, NY)

One way I get Physical Geology & Historical Geology students in my mid-Hudson Valley community college to apply new concepts is by giving them the option of studying a local rock outcrop for their final project. The process is really a mini-independent study as students apply what they learn in class about minerals, rocks, maps, geologic processes, and plate tectonics to "their" outcrop. I visit many of the students at their outcrops. Students can also share their own videos and photos of their site visits with me. The geology of most of the outcrops has not been recently described or interpreted in the geologic literature, or even in local hiking guidebooks, in any meaningful way, so students really must make their own observations and interpret them in order to unravel the geologic history of their outcrop.

Once students make their own primary observations and sketches, collect and describe samples, name the minerals and rocks they find, and make their own interpretations, then I help them find any related published resources, so they can weave together the geologic story of their outcrop. Students present their outcrop's history in either oral presentation or poster format to the class. Students must come to grips with geologic time and geologic processes. For example, at first they may associate the sandstone in their outcrop directly with the Hudson River flowing near the outcrop. But eventually they come to understand that the ancient sandstone is hundreds of millions of years old, while the Hudson in its present form is thousands of years old.

The goal of the local outcrop project is to promote hands-on learning and primary inquiry, to encourage students to spend time outside, and to work in the same process/style as a field geologist. This local outcrop project supports student success by integrating learning from throughout the semester. Students gain confidence as they apply what they learn, and they learn how to "tell" a geologic story.

The main strength of this local outcrop project is that the students share their outcrop story with the class, and together, the various outcrop presentations share the geologic history of the Hudson Valley with all the students in the class. The most valuable aspect of this local outcrop project is that students are DOING geology, not just studying geology topics. They use a compass to measure strike and dips, look at the published geologic map, and gain confidence in their mineral and rock identification skills.

One challenge to implementation is that some students are less prepared for the task and require more individual guidance. If students are weak on mineral or rock identification, or don't yet have a basic grasp on geologic time and processes, they flounder to understand the geologic story reflected in their outcrop.

My only evidence of effectiveness are comments students have shared, such as: I never even noticed rock outcrops before this class!; It's so cool that I know more about how this area changed over millions of years.; Now when I hike with my friends, I can talk to them about the rocks and geology. Some of them don't like that (smile); Geology used to be a class – now it's a way of thinking.

This local outcrop project supports geoscience success in two-year colleges by giving students confidence that they are ready to transfer to a four-year school to continue the study of geoscience.

Beginning a Geoscience Program at a Two-Year College

Brett Samantha Dooley
Assistant Professor of Biology & Geology at Patrick Henry Community College

I teach at Patrick Henry Community College, which resides in a fairly rural and economically depressed part of Virginia. Many of our students are first generation college students and are coming back to school for retraining after having lost a factory job. With the exception of earth science (GOL110), which is not a transferrable science course for general studies students and thus never had any significant enrollment, PHCC has only offered geology classes for four years. Having started the geology program at PHCC, there are three main areas upon which I am focusing to support geoscience students: introduction to the value of geoscience and access, transfer and career option, and training with workforce and transfer skills.

For non-traditional students, at the time they attended public school, earth science was either not offered at all, or not a requirement for graduation, thus is was not taken; even for traditional students, for whom earth science was a graduation requirement, many students had this class when they were in eighth grade, thus they have no working memory of it. A significant side effect of this is many students find no value in geosciences. Geosciences are perceived as either unimportant ("It's a middle school class," or "I didn't even need it to graduate.") or as a "baby" science, one not worthy of a college student. This may have been reinforced with the college offering only earth science, which again, did not transfer. By starting courses in physical geology and historical geology (which are transferable) students see that colleges do recognize and appreciate geosciences. For those who take the course, they find it is indeed rigorous and academically challenging. In four year geology courses have grown from not filling one section of one course, to now offering two courses (one section each) each semester.

Another important aspect for promoting student success is training in career skills. To help with this I am getting training to prepare myself to teach vital skills such as GIS. It waits to be seen how the implementation of GIS skills will go, but in the fall semester it will be incorporated into physical geology. Students will generate data sets, using hand held GPS units for self-selected projects, and map the results of their findings. I anticipate this project will be well received by students and will benefit them greatly. After talking with representatives from VAMLIS and The Timmons group, broad-scale knowledge of how to use GIS to solve problems, rather than heavy emphasis on the tools themselves, is most critical for prospective employees. After using these tools in multiple courses our students should be employable, and for many entry-level careers, a two-year degree will get them in the doors. Another element of incorporating GIS skills will be to tell students about what career options they have in both the private and public sectors.

Not only have students not had geoscience courses; they have had only limited exposure to science and frequently have science phobias. One of the most important things I try to do to support my students is train/encourage them to think critically and collaboratively about problems. One of the greatest complaints that I hear when talking to employers is that potential employees don't have the skills to work with a group to solve a problem. By providing my students with opportunities both to use current technologies and use these tools to solve real world problems with their peers, they will also be receiving training that will help them to pursue employment or to transfer to a four-year institution.

Zooming Out – A Dean's Perspective on Geoscience Student Success

Dave Douglass, Dean of Natural Sciences, Pasadena City College

Seven years ago I transitioned to a new role as Dean of the Natural Sciences Division after 20 years of teaching in a four–person Geology department. About 3 years into this new gig I read the paper "How Geoscientists Think and Learn" (Kastens et. al, EOS Trans. AGU, 90(31), 265) which caused me to reflect on why I was actually enjoying what I do and was having some success at it. Qualities of geoscientists such as having a broad perspective of time, understanding and appreciating the workings of complex dynamic systems, a sense of space, the adaptability and flexibility that comes from field work, and the sense of being part of a community of practice all have served me well in this new role. Currently I have the privilege of working with about 50 full-time faculty, 75 adjunct faculty, 10 classified personnel and over 6,000 students each term in a variety of disciplines from Biotechnology and Kinesiology to Geology and Physics.

The goal of my work today has shifted greatly from my role as a faculty. In one sense, I serve students by serving my faculty, helping them to be their best possible selves in their daily work. Largely this includes making it safe for them to try new teaching approaches, helping them to update and align their curriculum, getting them what they need to be great teachers, and generally trying to move obstacles out of their way. I find myself trying to say, as much as possible, "Here is how we get to yes".

As dean, I also see on a daily basis the broader challenges our geoscience students, and all STEM students, face beyond simply successfully completing their courses. Approximately 65% of our entering students test into developmental math and English. Therefore at our college, it is often several semesters into their college career before they really start being a STEM major. For many first generation college students, poor students and underrepresented minority students, there are too many exit points along their pathway to success. In one longitudinal study at our institution, only 35% of our general student population had either received a degree, a certificate or transferred to university after 6 years. For Latino students who began in either developmental math or English, that number drops to 29%.

We are certainly proud of the fact that every year we transfer geoscience students to places like Cal Tech, UCLA, Davis and Berkeley. Yet for many students who fall in love with their first geology class, without our support through their challenging course work in math, physics and chemistry (which they might not love quite as much as geology) they are unlikely to make it to the finish line.

The good news is that, in the geosciences, our field work naturally lends itself to the formation of learning communities and provides great opportunities for problem based learning—two important strategies in helping to engage underrepresented students in STEM. The better news is that we are also very interdisciplinary. We can bring relevant, real world problems into all the STEM fields that can engage students and give them a sense of purpose towards *completion* of a Geoscience degree.

Supporting Geoscience Education at the University of Wisconsin-Richland
(A 2-yr liberal arts institution)

Norlene Emerson, Associate Professor of Geology
Department of Geography /Geology, UW-Richland

As I reflect on the goals that I have to support student success in geoscience courses, my thoughts first turn toward strategies I use to connect with each student as an individual learner. Since our students each have different skills, prior knowledge, capabilities, and reasons for being in school, I seek ways to provide content in visual, tactile, and audio means so that each student can connect to the material in the form that best suits their learning styles in order to optimize their learning. While content is important, the process of learning is just as important in an educational experience. Today's students are bombarded with information through social media, television, and print media often with sensationalized information concerning the Earth and the environment. Students need to develop their skills to assess critically what they hear and read especially concerning world issues such as mineral and energy resources, climate change, or mitigating natural disasters.

In order to achieve these goals, I encourage students in taking ownership of their learning. I stress that being an "active learner" requires full engagement by both the student and the instructor, creating a two-way flow of knowledge, ideas, and opinions. In order to build that relationship, I begin by carefully listening to students to better understand their excitement, apprehension, fear, or possible indifference for the subject material. I try to find ways to make geoscience content relevant to students' lives. I share my own passion for geology as well as any challenges I may have had with learning any of the content material. I develop opportunities to listen, read, discuss, share, and engage in activities designed to help them conceptualize, experience, and reflect on the subject matter. Specific strategies include:

- Learning my students' names before the semester begins so that on the first day of class I can address them each by name.
- Requiring each student to drop by my office for a brief chat during the first two of weeks of the semester to help lessen the fear that some students have for seeking help from their professors outside of class.
- Frequent contact with students via email as well as face-to-face before, during, and after class for constant and timely feedback concerning class progress.
- Prior to class meetings students upload to a course "dropbox" their responses to a set of "pre-lecture" questions based on each day's reading assignment. This allows me to have a quick check for basic understanding of the material before class and facilitates better use of class time for addressing questions, incomplete understanding, or for delving deeper into the course material.
- Class lectures are interactive with frequent use of demonstrations, "minute papers", "think-pair-shares", "concept quizzes", and "lecture tutorials".
- Students are provided with a well-organized syllabus, course lecture notes, and specific grading criteria for all drafts and final products to help keep students on track.

The biggest challenges that I face with implementing the above include: the general time constraints that all busy faculty experience; the lack of funding to develop additional lab and field trip activities; and the few failures I have had with certain individual students to succeed in college.

Evidence for success consists of: overall positive student evaluations including written comments that often speak of my enthusiasm, engagement with students, my care and understanding, and how I challenge students' thinking; students who enroll in multiple courses that I teach because they value my teaching methods; being asked to serve on a former student's Master's thesis advisory committee; being selected (by students) as recipient of the "2012 Faculty of the Year" award; and recipient of awards from the University of Wisconsin System (2007, 2009, 2010) for excellence in teaching.

A New Geoscience Program in Energy and Sustainability Management

Kim M. Frashure, Assistant Professor of Energy and Sustainability
Bunker Hill Community College
Science and Engineering Department

In 2012, I co-designed and launched a new certificate program in Energy and Sustainability Management (ESM) at Bunker Hill Community College (BHCC). BHCC's mission statement highlights sustainability and, the goal of the ESM certificate program is to enhance marketability of graduates for jobs in the emerging fields of "green" facilities operation and renewable energy services. BHCC is a large, urban campus located in Boston, Massachusetts, with a current enrollment of 13,504 students *(1).* We are among the most diverse institutions in New England with 830 international students from 94 countries speaking 75 different languages *(1).* Opportunities exist at BHCC to recruit and develop a largely under-explored, new pool of diverse geoscientists. However, urban community college (CC) students who are interested in a geoscience career often possess challenges such as academic deficiencies in mathematics & English, and a lack of awareness about academic and career pathways, mentorships and resources. The ESM program was designed to include the following to ensure the success of our diverse student population: innovative curriculum and skills in energy and sustainability, an industry-based advisory board, a freshmen science seminar, and accelerated and contextualized learning in English.

In Massachusetts, clean energy employment has grown by 11.2% since 2011 *(2)*. The responsibility for greening-up current institutions is expected to fall upon incumbent workers including, facilities technicians, coordinators, specialists, and business administrators. Our goal was to create a new academic certificate program in sustainability for new and existing workers. After researching sector trends and credentials, the following new courses were developed: Survey of Renewable Energy, Green Buildings, Greening Existing Buildings, Sustainable Facilities Management, and Introduction to Geospatial Technology, and Project Management for Energy and Finance. We also leveraged existing coursework in Environmental Science and Sustainable Resource Conservation. The ESM program prepares students to take the U.S. Green Building Council's LEED Green Associate exam, a nationally recognized credential for sustainability professionals. We formed a clean energy industry-based advisory board to inform us about the job market, identify training needs, review curriculum, and offer support (e.g. internships, mentorship, supplies, and guest speakers). The ESM program provides students with new skills and specialized curriculum in energy efficiency, renewable energy and sustainability to make sustainable decisions in a greening economy.

Several proven instructional strategies were included in the ESM program to enhance student success. All new and full-time students at BHCC are expected to enroll in a Learning Community Seminar (LCS). We designed a LCS in Energy and Sustainability seminar specifically for our ESM students. The LCS includes faculty advising, critical thinking, success coaching, career exploration, peer-mentoring and community engagement. In 2010, the campus-wide LCS program experienced a year-to-year retention record that is 32% higher than our general student population *(1).* Next, we accelerated and contextualized our required English courses. For example, students can earn 6 credits in English during one semester. Contextualized learning is a proven instructional strategy relates subject matter content to real world applications *(3).* Energy and sustainability concepts are infused across the English curriculum. These instructional strategies will address academic gaps, while at the same time, provide guidance and support for CC students.

The ESM Certificate Program launched during the spring of 2013. We built in proven learning strategies that maximize the potential for both academic and personal growth for students in a career in energy and sustainability. The clean energy sector provides direct guidance and resources in our program design. We are currently developing a new associate's degree program and plan to incorporate the same valuable support mechanisms to support this new pool of geoscientists at the CC level.

References

1. Bunker Hill Community College 2010-2011 Fact Book. 2011.
http://www.bhcc.mass.edu/PDFs/BHCC-2010-2011-Fact-Book.pdf

2. Massachusetts Clean Energy Center. *2012. Clean Energy Industry Report*, 2012.
http://www.masscec.com/index.cfm/page/2012-Massachusetts-Clean-Energy-Industry-Report/cdid/13909/pid/11170

3. U.S. Department of Education. 2000. Contextual Teaching and Learning.
http://www.ed.gov/inits/teachers/exemplarypractices/#context

Acknowledgements:

The ESM program was co-developed by Professors Kim Frashure and Krista Reichert, Science and Engineering Department, Bunker Hill Community College, 250 Rutherford Avenue, Boston, Massachusetts, 02129.

The ESM program is supported by the Massachusetts Community Colleges & Workforce Development Transformation agenda, which is 100% funded through a $20 million grant from the U.S. Department of Labor, Employment & Training Administration TAACCCT. Grant Agreement #TC-22505-11-60-A-25

The Learning Community is a 2011 Engaged Campus Initiative Funded by a U.S. Department of Education Title III grant of $1.89 million. Extended by internal funding. Supports BHCC's core institutional goal of increasing student retention and program completion.

Supporting and Advancing Geoscience Education in Two-Year Colleges

Responses to Application Questions

Frank Granshaw, Portland Community College/Portland State University

Why are you interested in participating in the workshop?

I see this as a good follow-up to the short-course by the same title that I was involved in at the 2012 national GSA conference.

What could you contribute to the workshop?

- Over twenty years of community college teaching experience.
- Experience with a number of efforts to strengthen geoscience education in two-year colleges (e.g. Geo2YC and Role of 2Y Colleges planning workshop 2010).
- Experience with a number of university / community college collaborative projects (e.g. Teachers on the Leading Edge, UCORE community college REU project).
- The perspective of an adjunct faculty. A major portion of the community college geoscience work force.

What is one example of something you have done to improve student success?
What do you know about its effectiveness?

In addition to having developing a considerable amount of on-line curricula aimed at non-science majors taking geoscience courses, I have also been active in developing urban field labs for environmental and earth science at two of our four campuses. I am currently in the midst of writing a grant to develop professional development workshops designed to infuse more sustainability related fieldwork in our STEM courses district-wide.

Do you bring additional experience or expertise important to the workshop that was not covered in the previous questions?

I am currently involved in a university / community college effort to create a virtual geoscience community. The goal of this project is to create a virtual teaching and learning community that emphasizes skill building and knowledge attainment, student retention, and professional development through Earth Science and Geology curricula across the Portland metropolitan region.

If there is other information relevant to your application, please let us know here:

Though most of my teaching experience has been part-time, I have shared many of the same responsibilities as full-time faculty including serving on subject area curriculum and other college committee, grant writing, facilities planning, and personal hiring.

Creating lab tracks to accommodate diverse student populations in introductory laboratory classes

Jacquelyn Hams, Associate Professor, Earth Science, Los Angeles Valley College, Dept. of Earth Science

The goal(s) of the work you describe and how it supports student success

This essay will focus on the efforts to improve student success in geology laboratory courses at Los Angeles Valley College, a diverse 2YC located in greater Los Angeles. The lab classes have traditionally used lab manuals and field trips as the primary methods of instruction. As a result, a great number of students did not successfully complete or dropped the lab class for the following reasons:

- language barriers (this is an open enrollment institution with no pre-requisites)
- inability to understand the lab manuals (most are written for majors)
- failure to purchase the lab manual, and
- Inability to participate in weekend field trips due to a work schedule or child/parental care issues.

To address this, Lab Tracks or categories of exercises and activities from which students select those needed to complete the required laboratory credit hours were created. Lab Tracks consist of the following categories:

- Laboratory exercises
- Online interactive exercises
- Field trips
- Individual research projects. The students who participate in the research projects also present a PowerPoint presentation to the class at the end of the semester.

The strengths of your work and its most valuable aspect

Students are allowed to select from the categories they are most interested in and are not penalized for lack of participation in any component of the course such as field trip attendance. The most valuable aspect of Lab Tracks has been the discovery that many students have skills such as computer technology and public speaking that would be unknown without the research project and presentation component of the course.

The challenges you have had in implementation

Some students have been reluctant to participate in the research component because they have not used PowerPoint before. I address this challenge by having a lab session that is dedicated to the preparation of the PowerPoint presentation and I assist students with slide preparation. Students are also required to develop a hypothesis and have it approved by the instructor before proceeding with data collection on the research project to ensure successful completion of the research project component.

Any evidence of the effectiveness of this work

Comments gathered from student evaluations indicate that students feel that they are learning more from participating in the components of the course that truly interest them and not completing boring busy work. I am beginning to compile data on student completion, retention, and final grades.

Hams_essay.docx.

Supporting Geoscience Student Success

Anita Ho, Instructor, Flathead Valley Community College

While I look forward to the workshop and learning about additional strategies and resources for effectively teaching the range of students I see, here are a few approaches I use to support student success:

1. In my geoscience classes, I offer extra credit to students who bring back to class, after spring break, a photo of anything geoscience-related. The students share the photo with the class, describe the feature(s) in it and how it may have formed, and inevitably we also learn something personal about each student (where his or her relatives live, what they do as a hobby when not in school, etc.). Depending on the class, there may be excellent participation, and the show-and-tell can drive a fun and helpful review session after a long break. It's a simple and effective way to help students connect book learning and the real world; everyone likes to feel smart! Although I assign it as a spring break extra credit activity, I don't require students to go anywhere special, and have made a mental note to use it as a regular assignment in any class.

2. My lab classes usually only consist of 10 to 18 students. Even so, in lab, I rarely grade the work students do and turn in; rather, students simply earn points for attendance and participation. I encourage them to work in groups of 2 or 3, and always ask them to mix up the groups for each of the first few labs in the course so everyone gets to meet and work with everyone else. Eventually, regular groups form, although, rarely, a student will insist on working alone. During each lab period, after focusing the students' attention to the lab and giving a brief introduction to the topics, I rotate among the groups in the class to answer questions, review or reinforce concepts, and check students' work, correcting and clarifying as I go. The students know my goal for them during the period is for them to leave with a correct understanding of the concepts covered. Of course, they unavoidably lapse into chit-chat and general banter, which adds to the light atmosphere, but I come around often enough to focus their attention back to the lab, and the students know they need to keep on task to finish it within the lab period. I initial each page of their lab as I go, and students hand them in when they finish and leave. It's a simple matter to record the students' participation before returning the labs promptly the next day in class, when we might review or build on the same material. I find this weekly, low-pressure, sociable environment is conducive to student engagement and collaboration, and effectively motivates almost all students to contribute to and support their group's work.

3. Lastly, but definitely not least, I try to establish strong personal connections—between teacher and student, teacher and advisee, and between students—as early as possible in the semester. These relationships make a big difference in how students feel about the course(s), me as the teacher, and their understanding of my goals for them. It's important for students to know I want to see them work hard and succeed, and it makes a difference to me when I know a little about their backgrounds, goals or aspirations and life outside the classroom. And of course, one of the most gratifying aspects of a successful classroom is the rapport that students build with each other. Classrooms are small communities of people of different backgrounds and opinions, but the students are in it together: when they get to know each other, they are more likely to look forward to and enjoy coming to class, set up study groups outside of class and become collaborative and active learners. On the flip side, one of the major challenges to fostering strong relationships is the rare but inevitable student who habitually misses class or is absent for the first few days, regularly arrives late, leaves early, or otherwise does not interact with others, for whatever reason. There have been times when students mention, in informal evaluations at the end of the semester, that one of the most valuable aspects of the course was the connection they made with classmates, or having found some good study buddies and made some new friends. These comments suggest that an atmosphere that fosters collaboration and active group work is very effective in engaging students and supporting their academic success.

Preparing Our Workforce Initiative
Preparing Students at 2-Year Colleges for Geoscience Careers

Heather R. Houlton
American Geosciences Institute

Over the past year, I have developed a program called the "Preparing Our Workforce (POW) Initiative", which teaches students about the many different types of career opportunities that are available in the geosciences. I piloted the program by facilitating in depth and interactive discussions with geoscience students at 7 different institutions, including a 2-year college. The presentation emphasized the importance of integrating students' interests, within and outside of geoscience, and their transferrable skills to their geoscience career goals, which led to an increased awareness of the diversity of careers in the geoscience workforce. Additionally, I presented pertinent information about geoscience workforce trends, such as enrollments, supply and demand data and salaries of geoscientists. Lastly, I discussed best practices for networking and how to land a job or internship in our field.

The pilot program proved to be a great success – we received very positive feedback from both students and faculty through our online evaluation; 100% of respondents indicated that the presentation was valuable. In addition, 89% of respondents indicated that they had "little" or "moderate" awareness of geoscience careers prior to the discussion whereas after the discussion, 100% of respondents indicated they were "very aware" or "extremely aware" of geoscience careers. AGI is now working to expand the POW Initiative on a national scale. As part of the Geoscience Online Learning Initiative (GOLI) run by AGI and AIPG, I have developed a free, online course that teaches professionals (faculty and non-academic professionals) how to facilitate a POW discussion. The course introduces the content to professionals and teaches them best practices on how to effectively engage students and how to host career discussions. Upon successful completion of this course, professionals will be able to download all the information and handouts needed for the presentation. Additionally, they will receive professionally printed materials from AGI for free to distribute to students.

One particular strength of the POW Initiative is that the presentation is highly customizable. We encourage POW discussion leaders to include their own experiences and anecdotes, which personalizes the presentation and helps them relate to the audience. This flexible structure is great for the 2-year college demographic in particular because the presentation can easily change depending on the presenter and the needs of the audience. If you are interested in participating in the POW Initiative or have any questions regarding this opportunity, contact Heather Houlton at hrh@agiweb.org. If you would like to take the online course to gain access to the information and materials to host a POW discussion yourself, you can register for free at http://www.agiweb.org/workforce/pow.html.

I WILL TRY (ALMOST) ANYTHING ONCE!!!

Melvin Arthur Johnson
Assistant Professor
Department of Geography and Geology
University of Wisconsin-Manitowoc

Education is a life-long pursuit for me. I have continually attended school, not only for professional reasons, but also for personal interest. I share this interest in learning in whatever class I teach. I want the students to understand that education is an opportunity we need to embrace if we are to live in a society that is both wise and compassionate.

As an educator, I want to provide my students with new information, or a new way of looking at information that they may already know. I also want to give them the skills necessary to use the information in their day-to-day lives. I mentor my students recognizing the myriad of forces which affect their lives. While teaching at three Native American reservations, I helped students utilize their cultural backgrounds and current life challenges (children, tribal affairs, community demands, etc.) to view the world from a perspective that recognizes the wisdom and passion they have already achieved while incorporating the new knowledge they are gaining. I want my students to succeed, and it is my goal as an educator to assist them in their educational pursuits.

During my tenure as an instructor in community colleges and now in a 2-year liberal arts school, I have come to understand that teaching is both an art and a vocation. I also believe in the ideas of student ownership of the class and the instructor as a facilitator of knowledge acquisition and use. These concepts intrigue me. As a result, I have given papers at both anthropology and geography professional meetings on the topics of teaching concepts and techniques. I have given papers on teaching the concept of “post-modernism”, teaching about conflict and conflict resolution, the challenges of teaching world regional geography in “just one semester,” and the challenges encountered while teaching Native American students on reservations.

I have a policy of student interviews for all of my classes. The students are required to spend approximately 15 minutes talking with me either in my office or another appropriate venue. These conversations allow them to ask me questions, and, I hope, become more comfortable seeking timely assistance. They also help me understand their interests and goals, which enables me to tailor the course and the examples which I use in class to topics to which the students most relate. These have included music, art, fashion design, weddings, horse reining, soccer, football, home field advantage, carnivals, dictators, and many more. My goal is to help the students realize the role of geography in their day to day lives—and quite possibly gain some majors and minors from the classes.

In my Introduction to Geographic Information Sciences class I developed an assignment which brought a concern of our campus to the class for solving. The goals were: 1) a practical application of the principles taught in the class, and 2) an understanding of the complexity of solving a problem which involved three levels of government (city, county and state). They used data sources that were readily available to the average individual. They approached students, faculty, neighbors, city and county planning officials, and regional and national environmental organizations for data. The students then used those data to develop an answer to the question: “If UW-Manitowoc were to construct a new science building, where should it be located?” The students prepared posters and made a campus-wide presentation with their results. The response from the students and all interested parties was very encouraging. I plan to do another similar project for the next GIS class and perhaps incorporate it into my other classes as well.

Crafting an In-house Lab Manual for Community College Geology Students

Rebecca Kavage Adams, Adjunct Faculty Frederick Community College

I am creating an in-house lab manual for historical geology at Frederick Community College (FCC). The manual needs to be tailored to non-geology and non-science majors, be affordable, and capitalize on the samples and equipment available at FCC. At this point we are still using a published lab manual that costs $125 and is a poor fit for our students and available supplies.

I've cobbled together about half of the labs by selecting simple, hands on geoscience activities from a variety of sources (the SERC website chief among them) and modified them to best fit students with little to no background in science. My students have the chance to run a trial, collect data, analyze it, make hypothesis, and then modify their experiment. They learn the scientific method and see for themselves how geologists develop and use tools such as radiometric dating, dimensionless speed analysis, and fossil succession to make hypotheses about the age of the earth, speed of dinosaurs, and extinction events over time.

I've modified the math component of my labs to suit my math-phobic and math-gifted students. Problems range from simple velocity calculations and metric conversions to more challenging questions about confidence levels in age estimates from radiometric dating. I have also eliminated a lot of the detailed memorization that would be expected for geology majors. For example, students learn a limited number of rocks and fossils but spend more time using them to determine past sedimentary environments, climate, and extinction events.

The strongest part of my work is kinesthetic learning of the scientific process. Students who would otherwise sleep through a lecture on evolution are alert and invested in creating their own experiment, such as testing the survival rates of birds with different beak shapes. They love choosing new tools for beaks (open access to the lab supplies) and better imitations of food sources (from a bag of candy).

The biggest challenge, however, has been that many students expect cookbook labs with fill-in the blank answers. It takes them several weeks to get used to labs that incorporate some independent thought, and some never get used to it. I would like to achieve a balance of objective questions as well as provide a jumping off point where more advanced students can apply the skill being taught in the lab assignment, examine its drawbacks, and suggest ways to refine.

The other big hurdle I face in creating an in-house lab manual is funding to cover the amount of time I dedicate to the project as an adjunct, and for the supplies that would be required for the labs. I still want to create at least 5 more labs that incorporate current and local historical geology topics such as global warming, ocean acidification, and natural gas fracking. Supplies for these labs would be actual ocean sediment cores, foraminifera species that can be used as climate proxies, as well as more sedimentary structure and vertebrate samples.

Techniques I Use to Help My Students Think About Their Learning

Karen M. Kortz
Professor, Community College of Rhode Island

A lifelong skill is for students to think about their learning, or be metacognitive about it. Although metacognition ties directly to student success, it is often not taught, and it is a skill that many two-year college students lack. One of my goals is to purposefully structure my courses to help students focus on and be more aware of their own learning.

The three strategies to foster metacognition I use most often are:

1. ConcepTests (or clicker questions)—These multiple-choice questions are asked during a break in lecture, students individually answer them (anonymously), they debate the answer with their peers, and they vote again. These questions allow students to find out how well they understand concepts as they are taught in class.
2. Lecture Tutorials—These published worksheets are completed in class by groups of students and specifically address topics students have difficulties with. They are used after a short lecture to give students the chance to apply what they just learned. Students have the opportunity to teach each other and learn from each other. They can follow other students' thought process and vocalize their own. Again, students find out how well they understand the concepts during class.
3. Online Quizzes—These multiple-choice quizzes test the students on concepts they learned in class, but are completed by students on their own time outside of class. Students can retake them up to three times, with a different selection of questions each time. Students can use them as a way to self-test if they understand the concepts, which is useful both immediately after class as well as a way to study for the exam.

I explain to the students that these techniques give them immediate feedback on how well they understand concepts, helping them to realize that they are in charge of their learning and to determine what topics they need to spend more time on. Another strength of these methods is that they are easy for the instructor to implement. After the initial set up, none of these methods take much time, and there is no manual grading.

A challenge to these techniques is the initial time commitment, which varies. Good ConcepTest questions are difficult to write, but there are some on the SERC website, and you can reuse them in following semesters. Lecture Tutorials are pre-written, but do require creating enough time in class to implement. Setting up and writing good online quizzes also takes time initially, but they can also be reused (and some quiz questions can be used again on exams).

I have several indications that these techniques are effective with my two-year college students. When I ask students after each exam to reflect on how they studied as well as how they could have studied smarter (which is another technique to promote metacognition), students report using many of the strategies I provided, such as reviewing Lecture Tutorials and quizzes and focusing their studying on where their weaknesses were. When I've had students who have taken a class in which I used the online quizzes then take a class where I have not yet developed them, they unanimously asked for the quizzes, even though they require more work from the student. Although some students complained about the time involved, they also saw how valuable the quizzes were to their learning. Finally, as measured by the MSLQ survey instrument, students in my classes do not experience a decline in motivation and attitudes during the semester, as is commonly seen in other introductory classes, which is significant because research is increasingly showing the importance of student affective domain (motivation and attitudes) on their learning.

Kaatje Kraft
Mesa Community College
Physical Science Department
Geology Faculty

How can we broaden participation in the geosciences?

Broadening participation in the geosciences is both an issue of equity and practicality. Current job projections indicate that more than 90% of all STEM jobs will require at least some college within the next decade (Carnevale et al., 2010). By 2050, the current underrepresented population (Hispanic, African-American, Asian and mix of 2 or more races) will comprise nearly half of the population (Day, 1996), as a result, the current majority White population will no longer be the dominant contributors to the job market. If Science, Technology, Engineering and Mathematics (STEM) jobs currently held by the majority are not replaced and filled by individuals in the growing minority groups, the nation faces a possible crisis. In addition, those who obtain a college degree are more likely to be flexible as the job market shifts and changes with technological advances (Carnevale et al., 2010). Supporting students in the general education science classes to be successful becomes a critical step toward obtaining a college degree, particularly those who move into STEM fields.

Geology is a discipline that many students first discover in introductory geology classes at college (Houlton, 2010). Most students do not enroll with the intent of majoring in geology (Gilbert et al., 2012). In addition, geology is among the least diverse of the STEM disciplines. However, community college introductory geology classes are much more diverse due to the nature of their student populations (Gilbert et al., 2012). If we want to better understand how students, particularly underrepresented minorities (URMs), intend to persist in the geosciences, it makes sense to focus on the community college population. Targeting persistence can assure student success regardless of their future career goals.

In order to better assess how we can target this persistence, I am using data from the Geoscience Affective Research NETwork (GARNET) project. The GARNET project is an NSF-funded multi-institutional collaborative grant examining what motivates students to self-regulate their learning in introductory geology classes based on individual factors of motivation as well as classroom environments (McConnell et al., 2009). For my dissertation, I am currently looking at factors of motivation and interest among others as possible predictors for a student's intent to persist in the geosciences, particularly for community college students. Ultimately, I hope to be able to make initial recommendations about how we can support student persistence in the geosciences at the community college.

Carnevale, A. P., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of jobs and education requirements through 2018*. Washington D. C.: Georgetown University.

Day, J. C. (1996) *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*, U.S. Bureau of the Census, Current Population Reports, P25- 1130, U.S. Government Printing Office, Washington, DC, 1996.

Gilbert, L.A, Stempien, J., McConnell, D. A., Budd, D.A, van der Hoeven Kraft, K. J., Jones, M. H., Knight, C. C., Matheney, R. M., Perkins, D., and Wirth K. R. (2012) Not just rocks for jocks: Who are our introductory geology students and why are they here? *Journal of Geoscience Education*, *60*(4), 360-371.

Houlton, H. R. (2010). Geoscience major career choice: Investigation of pathways to lead students to the geosciences. *Geological Society of America Abstracts with Programs*, *42*(5), 585.

McConnell, D., Jones, M.H., Budd, D.A., Bykerk-Kauffman, A., Gilbert, L.A., Knight, C., Kraft, K.J., Nyman, M., Stempien, J., Vislova, T., Wirth, K.R., Perkins, D., Matheney, R.K., Nell, R.M. (October, 2009). Baseline Data on Motivation and Learning Strategies of Students in Physical Geology Courses at Multiple Institutions: GARNET Part 1, Overview. *Geological Society of America Abstracts*, *41*(7), 603.

More than the Classroom at Trinidad State Junior College in Southern Colorado

Debra Krumm, PhD
Geology/Biology Faculty
Trinidad State Junior College Math/Science Division

Addition of new faculty plus the receipt of U.S. Department of Education STEM grants has allowed for the expansion of science education at Trinidad State Junior College (TSJC) in southern Colorado. The ultimate goal of the STEM grants is to increase the number of Hispanic and low-income students going into STEM careers. To accomplish this, TSJC is working to create a STEM-friendly environment where students encounter other students interested in STEM subjects and where it is easier for them to find mentors and resources such as transfer information to help them accomplish their academic goals. The addition of new science faculty supports these efforts and broadens the opportunities available to students seeking Associate of Science degrees or transfer to Bachelor of Science STEM programs.

Trinidad State Junior College is located near the New Mexico border in south-central Colorado with a satellite campus in the San Luis Valley in the south-western part of the state. Both locations are rural with large minority populations and widespread poverty. Community college students raised in such areas are often first generation (neither parent has a bachelor's degree) and almost always need developmental math and English courses when they arrive. Therefore, majoring in the STEM disciplines is not on the radar for most freshmen at TSJC. This situation is compounded by a widespread lack of exposure to STEM careers in junior high and high school.

Both the TSJC science faculty and the STEM staff are working hard to change this situation. STEM academic coaches have started giving classroom presentations on STEM careers at the middle and high schools. They then act as mentors every step of the way as the students enter the college environment. A successful STEM staff/science faculty partnership has been the creation of a STEM student club. A geoscience faculty member acts as club advisor (myself) and a STEM staff member provides information on a different STEM career at each meeting (usually tied to a fun activity like Mentos in soda). The addition of new science faculty has also allowed for offering of new courses and for increasing undergraduate research opportunities. Previously, there were not enough courses in many STEM disciplines for students to be able to complete their A.S. degrees at TSJC before transferring to a 4-year school. Being able to expand options benefits both the students and college enrollment figures. A blossoming interest among the faculty in undergraduate research as well as additional resources supplied by the STEM grants complements the new courses and better prepares the students for what they can expect at 4-year colleges and universities. It also makes them more competitive for transfer.

Many obstacles remain such as concern over enrollment in new courses. This should improve as a STEM community of students is formed and word spreads. Maintaining interest in a STEM program over the two years of community college and beyond remains an obstacle as courses increase in difficulty. With our population, outside influences such as jobs and family constantly erode at a student's determination to finish. However, we are starting to see small successes after our first year combining mentoring with new classes, extra tutoring, clubs, field trips and other STEM-related opportunities. This all-encompassing approach to promoting STEM inside and outside of the classroom seems to excite both our student population and our STEM faculty and holds a lot of promise for the future of all sciences including geoscience at TSJC.

Building Success Skills into an Oceanography Curriculum

Lynsey LeMay
Geology Instructor
Thomas Nelson Community College, Hampton, VA

Student success and developing those necessary skills in students extends beyond the geosciences and while I use geoscience topics, I work to address and develop cross-curricular success skills throughout assignments all semester. This is true in all classes that I teach, but I will describe how this has been built into the introduction to oceanography classes at Thomas Nelson Community College.

Introduction to Oceanography is a relatively new course, only having been taught for two years. During the development phase of the course, it was decided that this course would have a field-based research project that students would spend about 6-7 weeks completing, and that all labs leading up to that project would aid students by exposing them to skills needed, many cross-curricular, to successfully complete the project. Not only was the goal of this to help students learn concepts and skills important to the project, but also to the success of the students by developing skills to support them in becoming better students and learners.

The first lab students complete involves graphing and data analysis. Students are asked to analyze and identify a few different graphs, determining if the graph is appropriate for the data given, and are then asked to make some of their own graphs using Microsoft Excel. Not only does this reinforce the necessity for quality data and appropriate displays of data, but it often introduces graphing tools, which are important in other disciplines as well. The next lab has students think about "doing science" where students revisit the steps of the scientific method, discussing the importance of following the method. Students are also given a simple question and then develop a hypothesis, and plan an experiment to test that question. The following week, students go out to the field to conduct their experiments, collect data, which is then analyzed and presented the following week. This three week mini field research project allows students an opportunity to practice not only following steps to complete a task, collecting and analyzing their own data, but allows for presentation skills to be practiced, including oral presentations and making a Powerpoint presentation. In subsequent weeks prior to the research project, labs include detailed opportunities for students to learn about conducting library research, accessing primary literature, and more examples of working with data that will more specifically apply to the project. Other labs focus on reading maps, careers in the geosciences, and making oceanography relevant to them, using local oceanographic examples, and sometimes visiting local research institutions.

The benefit to this structure is that students feel more confident with their research projects, because they are more familiar with research skills, data analysis, and presentation skills because it has been practiced throughout the semester. These are not new concepts and students are often more willing to truly take ownership of their projects because of this it seems. However, this has not come without challenges. One of the biggest challenges is student absences. When a student must be absent, they are missing the links of how all of these skills fit together to not only develop a strong end of semester project, but they often lose some of the relevance and how it can apply to their own student learning in general.

While the success of this structure has been somewhat dependent on the student, and the effort they make in completing the assignments, I have found that many of the cross-curricular skills like using Excel and Powerpoint, writing succinct, yet detailed, memos, and even conducting library research, are new to many students. Many of the geoscience specific skills are also new, and some find those in particular more challenging. However, because the assignments increase awareness of important skills, and allows for practice, many students end the semester more comfortable with the skills, and feel better armed to take control of their own learning, which I would consider a success.

Students Know More Than They Think They Know

Fred Marton, Department of Physical Sciences, Bergen Community College, Paramus, NJ 07652

One of the key challenges that I face in my introductory geology class is trying to show students who are not necessarily interested in science (and who sometimes do not have a good background in science and math) that the basic concepts we are trying to learn about are not overly complicated or specialized. To address this, I have used in-class group exercises and worksheets to introduce many topics. I want the students to use these exercises as a way of teaching themselves and therefore they are not asked to answer questions on topics that we have already spent time on (unless they have actually done the assigned reading). Instead, I present simplified scenarios or analogies that they can figure out by themselves and then I go on to explain and we explore how they are analogous to the topic of interest.

For example, to introduce the concept of radiometric dating, the students are given thirty-one nickels and one penny in a box. Once all the coins are heads-up, they shake the covered box and remove all the tails-up coins, recording the number of heads remaining, repeating until all the coins have flipped. In addition, they are asked to indicate when the penny flipped. They then repeat the experiment and answer a number of questions. By doing this, they will discover that although, on average, half of the coins in the box flip during each shake, no two trials are the same and the penny shows that any particular coin can flip at any time. In addition to their individual trials, I collect and plot all the groups' data as well as the cumulative results of all sections since I started this exercise in Spring 2012.[1]

I have found these types of exercises work well, overall. Most students do not find them difficult or confusing (though I am always working to improve and clarify the instructions) and they are simple enough that most students get the intended results and answers. The students like being able to take time during class to work together (if nothing more than to get me to stop talking; the classes are twice a week for two hours and forty-five minutes). In addition, these exercises account for 15% of their final grades, thereby giving them an opportunity to improve their grades. Most importantly, these exercises allow the students to see that many of the concepts we are covering in class are analogous to things in their personal experiences and that they are not some sort of incredibly complicated sciency weirdness.

Grading can also present a downside for the students. First, there can be confusion on what numerically is a good score (they are graded on a three-point scale). Second and more importantly, because individual work is graded, I collect the worksheets before going over the answers, so unless they immediately take notes, students may not retain the lesson as well as possible (I do return corrected work to them by the next class). Finally, the time when they are working on the exercises creates pressure on them and affects the flow of the class, given that they work in groups and may have to wait for other groups to finish before the class goes over everything together. An alternative I have considered is to have the students work together in their groups and then, prior to my collecting the worksheets, have the class as whole go over the answers. This would necessitate a different grading strategy, as some students may not be above erasing incorrect answers.

Overall, I have found that these exercises have been helpful to and enjoyable for the students. Anecdotally, students often refer to how much they liked them on evaluations, and they usually do well when they are given identical or similar test questions. Also, I try to include concepts that are reflected in our lab exercises, showing the students that all elements of the class reinforce each other. The biggest surprise for my students is when, going over the concepts, they come-up with an answer or explanation based on their own experiences and, when applying it to the geologic concepts, ask, "Really? That's it? It's obvious."

---

1 http://serc.carleton.edu/details/images/40190.html

Ongoing Involvement and Taking Ownership of your Education: Homework, Feedback, and Interactions

Steve May – Geology, Astronomy, & Physics Instructor
Walla Walla Community College

As a full-time physical sciences instructor at Walla Walla Community College, a rural 2-year college, and an adjunction geology professor at Whitman College, a small liberal arts college, I work with two significantly different types of college students. I am often asked about the differences I observed between these two groups and the answer is a fairly simple one, and maybe not what people expect. Yes, the Whitman students probably have somewhat better entrance exam scores, but that is not what I believe to be the most significant difference – to me it is the fact that most of the 2-year students do not feel any real ownership of their education, whereas the Whitman students expect a great deal of themselves, as well as their professors. The way these differences manifest themselves is that a professor at Whitman can expect the vast majority of their students to show up for each class having fully prepared themselves for the topics to be discussed and ready to ask informed questions during class; whereas the 2-year college students need some strong inducements to learn the value of being prepared and what it feels like to have some sense of control and involvement regarding their education.

Some inducements I have employed are: daily homework (with feedback), daily comments, and post-exam reflection.

Daily Homework – I know it sounds old fashion, but classes in physics, chemistry, and mathematics generally have homework that is turned in on a daily basis, whereas in most other subjects, including geosciences, it is not common to require daily homework. During the past 5 years I have assigned daily homework in both an introductory earth science course and an introduction to climate course. The homework is generally review questions and problems from the textbook. The twist in the assignments for these classes, compared to my physics classes, is that the homework is completed and turned in before I lecture on the material. Requiring students do the reading and hopefully some synthesizing of concepts before coming to class makes for a more attentive and engaged learner in my experience. There are both positive and negatives aspects to this approach.

- Students are definitely better prepared for class
- Since homework is only accepted at the beginning of class and must be turned in by the student themself; attendance improves with a significant decrease in tardiness
- Grading of the homework is done "gently" with lots of partial credit, encouraging all students to at least attempt the questions
- Instructor time for grading is somewhat of an issue, but I have dramatically reduced that by posting audio-visual answers on the class website after the assignment is due (I use **screencast**-o-matic.com)

Daily Comments – This is my version of the classic "muddiest point" classroom assessment technique, which also serves as effective attendance monitoring. At the end of class I have students fill out cards that ask: Today I Learned _____; and Comment_____. The first part is meant for them to recall the central topics of the day and the second is any optional comment they would like to make. I encourage students to ask just about anything here. I try and open every day's class by offering my comments on whatever students have had to say. It is amazing how quickly they learn that I want them to offer up just about anything and they begin to realize that we are all in the class to learn together. This technique gives the students a true sense of ownership in the class and has become one of my favorite parts of teaching.

Post-Exam Reflection – I have trying this method a few times when a class has a particularly difficult time with an exam, especially if it is the first exam of the term. By getting them to think about their generally study habits and exam preparations it has proven quite effective in improving subsequent exam performance.

I know that I am not suggesting anything revolutionary here, but sometimes it is the simple stuff that can really make a difference when dealing with the underprepared, both academically and in terms of study skills, students that make up a significant portion of our 2-year college population.

Activities That Support Student Success in Traditional and Online Introductory Geoscience Courses at Wake Tech

Gretchen Miller
Geology Instructor - Natural Sciences, Health, and PE Department
Wake Technical Community College (Wake Tech)

I teach two introductory geoscience courses at Wake Tech, GEL 120: Physical Geology and GEL 230: Environmental Geology. I teach both courses in traditional, seated environments as well as online. All of our introductory geoscience courses (including the online sections) require both lecture and laboratory sessions and are 4 credit hour courses.

I utilize a lot of active learning and "just in time" teaching techniques in all of my classes. For example, I require that my seated GEL 120 students read sections of their textbook before covering the material in lecture so they can become familiar with the new terminology. To make sure they complete the reading, the students must take an online vocabulary quiz that is due right before class. Once in lecture, I can then focus on teaching the more difficult concepts and not spend time defining every new word. Our classroom time is much more effective when they have been exposed to the topics and vocabulary first.

Wake Tech has been on the cutting edge of online education for a long time, and I have been teaching GEL 120 online for 8 years. These are not hybrid courses, the online students borrow a set of laboratory supplies for the semester in order to complete assignments on their own. One challenge to teaching online is that many students have a misconception that online classes will be "easy," however, our online sections are just as rigorous as our seated sections. This tends to increase the attrition rates in the online sections.

One method I utilize to increase the success of students in my online classes is a highly interactive discussion board assignment. Most students are very hesitant to ask the instructor for help, but they are comfortable asking each other questions. So students in my online sections are required (enforced via grades and attendance) to help each other work through the assignments each week, much like lab partners or small groups would work together in a seated class. The only assignments on which they may not collaborate are the tests. I monitor the discussions to check for incorrect answers, or to point them in the right direction if they cannot figure something out themselves. I found that most students started earning higher grades on assignments and tests after I implemented this assignment, and they become more comfortable asking me for help when needed.

Finally, Wake Tech is in the second year of a collaboration with North Carolina State University (NC State) to increase the number and diversity of students pursuing a geoscience degree through a National Science Foundation Diversity in the Geosciences grant. While the main focus of the grant is to recruit geoscience majors, we are utilizing methods to increase interest and understanding of geoscience for all students. For example, we make connections between geoscience and activities that our students do every day, so they can see the relevance of what they are learning. Giving students a reason to want to learn, other than just getting a credit for their transcript, will also help them be better citizens later in life.

Geoscience Projects That Bring the Community into the Classroom
Mike Phillips
Geology Professor
Illinois Valley Community College

I began my professional career working full-time as an environmental geologist outside of academia. I began teaching evening classes at a community college because I wanted to show students that geology was not just as an interesting look into how the earth operates but how the study of the earth directly impacts their lives. To that end, I have used my consulting experiences to shape my assignments, my instruction, and my community outreach.

I have students complete projects that provide them with the incentive and opportunity to examine their surroundings. In my Environmental Geology course, students must complete a capstone project where they investigate the hazards and resources in the area around their home. In my Natural Disasters course, students complete two projects each describing a single type of hazard and its impact on the community where they live or would like to live.

These projects are successful because they provide students the opportunity to apply material covered in class to their personal surroundings. Although most students do not intend to pursue a career in geoscience, by providing them with a practical example of what geologists actually do, some may choose to become geologists while others will know when it is prudent to consult one. Because students have a personal connection to the project area, they are able to connect the geologic information to pre-existing knowledge, which improves retention. Former students comment on the value of the projects as they have made adjustments to their homes, changed their insurance coverage, and shared information with family, friends, and neighbors.

The students' projects are important to me professionally because they enhance my knowledge of the local area and improve my understanding of how students perceive the material we cover. When I read and assess the students' projects, I can see how the students interpret the course material and apply it in real-world situations. In some instances, this has led to changes in how the material is presented in class; while in others, it has provided evidence that students have developed a deep understanding.

The primary challenges have been to ensure students have a clear understanding of my expectations and access to appropriate data sources. To address the first challenge, I have incorporated data collection and reporting for the project in many of the lab exercises, which allows me to provide useful feedback on their work prior to the submission of the final project. To address the second challenge, I have created a web-based resource page and devote class time throughout the semester to class discussions of where and how to collect data and assess its quality.

SERC/ Cutting Edge Activity Descriptions:

Environmental Geology of the Area Where You Live:
http://serc.carleton.edu/NAGTWorkshops/intro/activities/23424.html

Natural Hazards Term Project:
http://serc.carleton.edu/NAGTWorkshops/environmental/activities/62809.html

Steps towards Creating an Engaging Earth Science Curriculum

Eriks Puris: Portland Community College

When I teach I strive to “put the phenomena first” and to “put observations before explanations” I do this not because I want to, but because I have found it to work. Initially in my teaching I stressed the understanding and appreciation of the basic physical and chemical processes which underlie the workings of the Earth, unfortunately this approach did not get me far with community college students. Eventually by trial and error I found it important to describe what I was explaining before explaining it. In retrospect this is less than surprising, but at the time it was an important realization to me! I have found students to be more likely to ‘bite’ and engage in learning if I begin with specific examples which are accessible and relevant to the students. My goal in teaching is to engage students in learning about the Earth, to make science accessible and to provide a solid foundation for those students interested in pursuing earth science careers. To achieve these goals I find myself reorganizing courses around engaging accessible and relevant topics. I begin G201 Physical Geology with the eruption of Mount St. Helens, not mineral structures as the text would have it. I begin G202 surficial process with the Missoula Floods, not landslides as the text would have it. I begin G203 historical geology with the Younger Dryas impact hypothesis not the Archean as the text would have it. I begin GS108 Oceanography with coastal processes along the Oregon shore, not plate tectonics of the sea floor as the text would have it. In each case the texts’ initial topics, which are typically abstract and far from the students’ daily experience, are replaced by topics which are more relevant and accessible to the students. The first quarter or so of each course is spent exploring these topics and building up the earth science knowledge required to explain them. This creates challenges in that additional prep time is required to develop well researched initial case studies and that the course structure no longer matches the structure of the text. To keep my teaching accessible I minimize vocabulary and calculations as much as possible. In place of having the students learn disarticulated flash card factoids I stress the development of explanations which ‘connect the dots’ and test the students’ ability to do this by including written response questions in my tests. I have not found a way to successfully minimize quantification. In general each course I teach includes one or two labs which are largely quantitative in nature and these labs ‘trip up’ the third or so of my students which are poorly prepared in math and/or have math anxiety. A further challenge is to increase the relevancy of my courses by thoroughly integrating hazards, resources and global change into every topic rather than leaving them relegated to the ghetto of the penultimate and ultimate chapters as is common in most earth science texts. Also important to student success are field based and independent research learning experiences. I was instrumental in rewriting course level learning outcomes for geology and general science courses to include field based learning. All my courses include some sort of field based learning component and I have reorganized my teaching load so that I will be able to teach a one unit field methods class each quarter during the 2013/2014 academic year. I have worked with the UCORE (Undergraduate Catalytic Outreach & Research Experiences) and IDES(Increasing Diversity in the Earth Sciences) programs to provide students with mentored off campus independent research experiences, and have had some of these students return to my classes to share their experiences and encourage further student participation in these programs. This year I created an independent study courses in geology which will be available to student for the first time next academic year. An upcoming challenge is to create low barrier to entry research experiences which can be incorporated into my courses and hopefully provide gateway experiences to independent study. As always a further challenge is to institutionalize these curriculum improvements in such a manner that they are accessible to part-time faculty. At this time I find myself strongly favoring learning experiences which stress depth over breadth but am challenged in implementing them.

Coyote in the classroom

Ethan Reese-Whiting, Northwest Arkansas Community College

My instructional approach has evolved to focus on active and inquiry-based learning as a means of exploring concepts in the general geology classroom. This has grown out of my involvement with the Eight Shields model of the learning journey and art of mentoring as described in "Coyote's Guide to Connecting with Nature" by Jon Young, Ellen Haas, and Evan McGown. While I am still in the early stages of adapting this model to the traditional classroom setting, I believe its approach has value in the general geology classroom as a means of pulling at students' edges of understanding and inspiring their curiosity rather than pushing them toward specific goalposts via the traditional lecture model. The application of this approach also forces me to discern between the material that is "need to know" versus that which is "nice to know." This helps provide focus in the classroom and reduces the chances to overwhelm students with minutiae they can easily find in the textbook.

This philosophy of geoscience education includes streamlining the class in several ways. The first is to downplay the vocabulary-intensive nature of geology. Since I deal primarily with students who are non-science majors, I seek to promote understanding of important concepts rather than rote memorization of terminology. I would much rather have a student understand that slow cooling results in larger crystals in igneous rock due to longer growth periods than simply regurgitate a book definition for the word "phaneritic" without any real understanding of the concept that word is meant to convey. This also helps make the material more approachable for English-language learners as it helps break down "vocabulary barriers." The focus on internalization and understanding of core concepts on students' personal levels also facilitates practical and situational application of these ideas in the field.

These approaches are designed to help in reaching the primary goals of promoting understanding of core concepts, promoting curiosity about geology and the natural world in general, and developing and applying critical thinking skills. To sum it up in somewhat glib terms, my intent is to help students "walk the walk" of geology rather than simply "talk the talk." I believe one of the key strengths of this approach is it makes the science more approachable to general geology students. Many of the students I encounter are intimidated by science and math in general. My approach helps them make connections between what we learn in the classroom and what they see in the real world around them. It helps transform geosciences, and science in general, from a subject veiled in academic mystery to something that has direct relation to their everyday life.

Teaching in this manner is not without its challenges. Students are often not used to exploring ideas from different angles, addressing more open-ended questions, or defending their thinking. They are used to classes where there is "one right way" to address a challenge. My questioning often involves describing scenarios they may find themselves in that require application of concepts rather than memorized facts. Students also find it challenging to personalize the information when I tell them, "If it works for you and it's not cheating, then go for it." I also have the challenge of making sure I properly scaffold their learning so there is not a huge leap between developing their skill sets and application during formal assessments. The greatest measure of success I personally have is that many of my students come to my classes with stories of how they noticed the offset in the rocks on the highway, how they couldn't stop wondering about the landforms they saw during spring break, or the elation they felt when they realized a tour guide was talking about an extrusive rock formation rather than an intrusive one.

Student Response Devices and Online Homework to Support Geoscience Student Success in Traditional Lectures, Distance Learning and Online

Bill D. Richards, Lead Instructor
Geology/Geography Department
North Idaho College

At this institution, the majority of students enroll in a geoscience course to fulfill a laboratory science requirement for the Associates' degree and mostly in Physical Geology (approx. 140 per semester and 40 during the summer session) and Physical Geography (approx. 120 per semester and 30 during summer session). Many 2yc students are not prepared for the level of "active learning" necessary to be successful in content-heavy lecture courses such as Physical Geology and providing students opportunities to become more active in their own learning process is a major focus of my curriculum development. A major activity within my freshmen courses is the use of the interactive student response devices (specifically the Q6 model from Qwizdom). The goal of implementing response devices is to keep students more active in the traditional lecture setting and provide feedback to the class. Planned self-assessment questions can be placed within an organized lecture presentation or presented in an impromptu fashion in response to specific topic diversions that occur. The devices are also used to randomly select students to answer questions with the goal of enforcing the idea of "being prepared" with the topic(s) for the day (I have to give extra credit for this to have any effect, though). Also, the Qwizdom system allows students at distance-learning sites to connect and participate through smartphone- or tablet-based internet connections. The specific model of response device that I use permits short text answer response (through a keypad just like texting on a phone, so most students feel comfortable). This feature is used to stress to students the need for proper spelling of terms and I incorporate this into advising students how to best study what many see as an overwhelming terminology (practice spelling the term as part of your "flash-card" drill). However, a major challenge has been the reluctance of students to practice the spelling as part of their learning ("Why can't I use a spell-checker"?). The best solution for this challenge has been to remind students that the devices are also how they will enter graded test responses and the system requires proper spelling to receive credit! Through the course of the semester, I can observe that more students arrive prepared and remain more active in the daily lecture, and assessment activities that require short answer written responses contain correctly spelled terms!

Another course activity that I have implemented is providing students "time-on-task" opportunities through Pearson's MasteringGeology and MasteringGeography platforms. My ultimate motivation is to use these platforms to initiate a "flipped classroom" setting requiring students to complete specific activities that I have setup on the platforms, both with the Pearson content and my own, prior to coming to a specific class lecture. A major challenge is how to enforce the requirement. In any case, a pre-lecture assessment will be given (using the Qwizdom response devices) over the assigned Mastering activities to help gauge the participation and monitor success. In the four semesters that I have used these "homework" platforms, I can anecdotally provide that students using the activities in the suggested manner, do fall in the higher percentiles on major exams (is this the result of the activities or a pre-existing qualification of the student?). Perhaps participants in this workshop can provide suggestions for the use of the activities to provide a more complete "flipping" experience.

Geology: The Foundation of Everyday Life

Rob Rohrbaugh

El Paso Community College

Over the past five years I have been a geology instructor for college and high school students in the border town of El Paso, Texas. El Paso also consists of one of the largest military installations in the country. These demographic factors create a very diverse student population, both culturally and socio-economically. Coupled with the student demographic, El Paso also consists of some of the most ideal geological exposures in the country. My geologic study at the University of Texas El Paso provided immense local knowledge of the regional geologic setting, which has become my trademark as a field oriented instructor.

Most of the students I encounter, have had little or no exposure to natural processes or settings. My classes are typically a gateway into the natural world, and my numerous field trips, play a key role in triggering interest into the geologic realm. My foundational instructional strategy is correlating all my class content with everyday life necessities and hazards that can impact everyday life. Sustaining that correlation of content to life significantly enhances content retention and interest.

Having just completed three years of high school instruction, in conjunction with 2-year college instruction, I have obtained unique insight into the typical academic abilities of incoming students. I will utilize this unique insight to provide a transitional instructional strategy that builds academic development for the rigors college instruction.

Constantly evolving my instructional methods for efficiency and effectiveness is a yearly goal in order to maximize both the educational impact and awareness of my students. Creating stronger individuals with a heightened conscious of geoscience is my prime directive.

Back to basics using scientific reasoning

Mariela Salas de la Cruz, Assistant Professor
Physical/Env Sciences Department at Quinsigamond Community College

Any teaching techniques I have tried so far all revolve around the same goal: teaching my students the process of science, from the scientific method to using communication skills to explain their findings. Many of my students come to my course with a fear of science; most of them truly believe that they are not good in sciences. So, in this short essay I will explain two of my most influential activities that so far, have changed the dynamic of my courses. Instead of pushing the science, I prefer to explain the discovery process before I tackle any geoscience topic. Two activities are used: (1) What is it? (2) Describe and Sketch.

The first activity called "What is it?" is a simple activity using your senses. I give my students a box with different items for example, a rock for the touch, food for the smell and a bag of sprinkles for sound. This activity does not involve taste or sight therefore they need to have their eyes closed while going through each object. After each student interacted with each object the boxed is closed. In a sheet of paper, each student writes notes. At this point I like to test their ability to take notes; I often don't give precise instructions on what should be written in the notes. I leave it up to them. A class discussion culminates the activity. This activity is a fantastic way for students to learn about their own discovery process. The first thing students say after the activity is "Wow, that was fun!" From the class discussion students notice how they describe, some mention how they try really hard to find an object they've seen previously and use that as a descriptor and other focus on what they got correct/incorrect. I ask for what techniques where used in the identification process and each student is eager to tell me. Students listened to one another, often fascinated by how each group came up with a solution. Another important part I like to discuss is their note-taking. Each group did a great job explaining the process of identification verbally but, none of the amazing techniques used was written. In fact, very rarely have I had students writing their methodology, descriptions (i.e. size or feel) or sketches in their notes; they simply write the name of the object. This is one major challenge that I tackle every semester.

The second activity, called Describe and Sketch, ties nicely with the 1st activity. Students work in pairs, they sit back to back. Between them they decide which person will be the describer and sketcher. The describer will hold an object where he/she will proceed to describe the object without naming it. Sketcher upon descriptions will sketch the object to the best of its abilities. A class discussion culminates the activity. One of the major discoveries students find among themselves is the ambiguity of the descriptions. The sketchers realize the inability to generate an image when the descriptions are not clear. The descriptors often mention about not knowing what words to use especially if the object was too simple (i.e. marker) or too complicated (i.e. picture of a trilobite). This activity is an eye opener for many students. I ask them in what ways they could fix these issues and there is always one student that mentions "it would be easier if we could measure it". This is the moment because students realize how communication skills matter and how math in science adds a level of clarity to our findings.

Both of these activities are very simple but powerful, they are the basis of my course. During the entire semester students observe, generate hypotheses, put it to the test and conclude. My entire curriculum is created on continually building on this process. If by the end of the semester my students know the direction of propagation of a seismic wave and its particle motion that is awesome. But, what really matters is that they learned the skills of a scientist and how useful the scientific process can be to our daily lives.

A brief consideration of the correlation of pre- and post-testing as an indicator of student success in geology classes

Joanna Scheffler, Adjunct faculty in geology, Mesa Community College

In the last two years my classes have been part of the GARNET (Geoscience Affective Research Network) project, with which some of the participants in this SAGE workshop are familiar. In this project, students were asked to fill out an MSLQ (Motivated Strategies for Learning Questionnaire) at the beginning and toward the end of the semesters. In addition, the students took a pre-test and post-test of general concept geologic questions. I am by no means a statistician, but MSLQ surveys have not shown much movement between the first and second runs. I had hoped the general concepts pre/post –tests would show big differences, particularly since many students missed half or more of the questions in the pre-test. With few exceptions scores did improve in post-tests, but not as much as I had hoped. This held true in the second year (2012-2013 academic year) of the study, even though I have been addressing some learning strategies directly in my classes. Primarily I have asked my students to reflect on what their goals are for the class and how they intend to achieve those, followed by later assessments of where they stand on those goals. I have discovered that even for this low stakes concepts assessment I have to resist "teaching to the test". I have also been working on making my lecture classes more inquiry-based and less lecture-based.

I believe that the numbers from the GARNET work are not the only standard of student success in my classes, although much of my basis for this is anecdotal. For instance, I have a reasonably high retention rate (80+% by my informal calculations; I have found a few statistics of retention in the geosciences at individual schools but not for two-year schools in general) of students who finish the class. Students tell me "they always look at rocks now when they go for walks or trips" or "this class made rocks interesting and I didn't think it would" (quotes mine). Very few of my students say at the beginning of the term they plan on majoring in geosciences, but occasionally one will tell me they've decided to switch to geosciences. These outcomes are not so easily quantified.

My strategies for achieving student success in my geology classes are tempered by the fact that my formal background is strictly geologic and my teaching is experience based. I am only cursorily familiar with many education concepts (for instance, I have never been completely comfortable with the term "metacognition").Therefore, much of what I try to accomplish with my students is based on my own observations of what seems to work. I will experiment with different activities that may be class-based or out- of- class based; however, I need to be more consistent in gathering feedback (both assessed or as student opinion) to determine what the students retain from such activities. Among the impediments I find in my continuing attempts to improve the outcomes of my classes is the time and schedule demands. Having to meet the schedule of lab topics or meet a list of competencies can challenge the implementation of what I consider meaningful activities; I need to learn to better balance these factors and perhaps to design more encompassing activities. However, my strengths lie in my passion for teaching a subject I love and my philosophy that teachers need to respect the student. Every student is capable of absorbing knowledge if encouraged to do so in a way that connects with them.

For more information on the GARNET project: http://serc.carleton.edu/garnet/index.html

Writing research-supported learning material for introductory geosciences

Jessica Smay
San Jose City College

Writing a Lecture Tutorial Workbook:

Lecture Tutorials are 1 to 3 page worksheets that use different questioning approaches, such as figure interpretation and Socratic questioning, to assist students in learning difficult concepts and overcoming misconceptions. The goal of our work is to make well-written and effective Lecture Tutorial worksheets available for instructors to use with their students in the classroom.

Some strengths of this work are that these worksheets increase the interactive component of lecture, allow students to participate in and evaluate their own learning, and give students the opportunity to "talk science" with each other, skills that are useful for the success of two-year college students. Lecture Tutorials are also easy for instructors to use and can be inserted into a previously prepared lecture.

One major challenge has been to publicize their existence and coach faculty how to use them most effectively. We were able to design a SERC webpage about Lecture Tutorials (see url below), to increase awareness and promote effective use. Also, the publisher WH Freeman has been helpful in marketing the book by distributing free instructors copies and funding and hosting workshops and webinars.

Karen Kortz and I found in a research study that not only do Lecture Tutorials increase learning by 12% over an extended lecture on the same material, but also that most students, especially two-year college students, like them and find them to be useful.

Writing a New Introductory Geology Textbook:

Another type of material that I have been designing for introductory geoscience classes is a new textbook. Anecdotally, many faculty members do not think their students get much out of their textbooks, either because the students do not read them, or because they become confused by the details and jargon. In order to address these issues, Karen Kortz and I are working on creating a textbook which will be of high interest to faculty with these concerns. We have an estimated publication date in late 2014.

The goal of the work is to create a textbook based on cutting edge research about how introductory students learn. Some of the strengths of this textbook are that it has a very strong focus on figures and images, cuts out less relevant details emphasizing the major concepts, and has a reduced number of geology-specific terms. We hope to increase student success in two-year college geology courses by giving them a new tool (the textbook) to learn the fundamental concepts of geology.

One challenge we anticipate is to win over instructors who currently use other textbooks, because this new textbook is so revolutionary. Preliminary research results suggest that two-year college students prefer this new style of textbook, feel they would learn more from it, and predict that they would be more likely to read it than traditional textbooks.

SERC website about Lecture Tutorials:
http://serc.carleton.edu/NAGTWorkshops/teaching_methods/lecture_tutorials/index.html

W H Freeman website about the Lecture Tutorial workbook:
http://www.whfreeman.com/Catalog/product/lecturetutorialsinintroductorygeoscience-secondedition-kortz

Accepting the Challenge

JoAnn Thissen, Associate Professor
Physical Sciences Department
Nassau Community College, Garden City, NY

Because our department does not offer any type of program in the geosciences it's up to each faculty member to introduce students to the geoscience classes we offer. As I am the only full-time geoscience instructor, that job falls on me. I begin what I call my "PR push" with my Earth Science Club. We advertise widely across campus and there's no where you can go without running into one of our posters, we participate in all college-wide events aimed at students, have fundraisers and do work for charity. This introduces students to the fact that a) we offer geoscience classes and b) we can have fun. Sounds simple but it's very effective. Our club membership and attendance at our meeting grows every year. This past year we were the largest, most well attended club on campus.

But getting their attention does not always mean getting them into and keeping them in class. That's where my curriculum and teaching style comes into the picture. I believe in hands-on, active learning and it starts from the first day of class. They are active participants in their own learning. But to get them to do that I need to be just as much an active participant. My love of my subject and enthusiasm for the Earth and oceans is reflected in how I conduct my classes. Many students who decide to go on to become majors tell me that my love for my subject inspired them. It humbles me.

My department chair told me that our geology program was all but dead until I took over. We barely had one section of Physical Geology and one of Historical Geology. no one was teaching the Field Geology class. Now we have multiple sections of Physical and have just hired an additional full-timer and several adjuncts to cover the multiple sections. The Field Geology class is so popular that we had to offer an additional section this year. I also developed a new course called Beaches and Coasts (a non lab science course) that is very popular.

This hasn't been without major challenges. In all of my classes, lab and non-lab students must learn to think like scientists, conduct research, collect and analyze data and write their findings in reports or make presentations. The issue is that most of my students cannot write or don't want to make the effort. I'm writing this essay after coming off a spring term and a field course that were incredibly frustrating for me. Even after giving detailed WRITTEN instructions, going over them, having endless discussions with them, outlining the papers with them, giving them sources to start them off- I got complete drivel- with the exception of my honors students and my (possible) majors. And with the exception, this term, of my Beaches and Coasts course - they had to conduct a term long study of a beach of their choosing (with my approval) and submit a PowerPoint presentation that included very specific information. A huge success and I'm very proud of them.

The challenge I've accepted is finding a way to have the same success with all my classes. While it's not my job to teach them to write, it is my job to get them to see science with new eyes and maybe make more geoscience majors.

Using On Course Principles to Support Student Success

by Alan Trujillo, Distinguished Teaching Professor of Oceanography
Dept. of Earth, Space, & Aviation Sciences, Palomar College, San Marcos, CA.

Palomar College faculty have recently received four-day On Course Workshop training on incorporating On Course strategies in their classrooms. On Course is a series of learning strategies for empowering students to become active, responsible learners. There is abundant data that demonstrates how On Course active learning strategies have increased student retention and success. Dr. Skip Downing details On Course strategies in his textbook, *On Course: Strategies for Creating Success in College and in Life* (Cengage Learning), which is used in college success courses.

On Course instructional strategies model current understanding of how meaningful learning occurs. As such, On Course strategies are designed to engage learners in the active construction of knowledge and are guided by the following principles:

- Students construct learning primarily as a result of what they think, feel, and do (and less so by what their instructors say and do). Consequently, in formal education, the deepest learning is provided by a well-designed educational experience.
- The most effective learners are empowered learners, who are characterized by self-responsibility, self-motivation, self-management, interdependence, self-awareness, life-long learning, emotional intelligence, and high self-esteem.
- At the intersection of a well-designed educational experience and an empowered learner lies the opportunity for deep and transformational learning and the path to success—academic, personal, and professional.

During the past two years, more than 90 Palomar College faculty from a variety of disciplines have attended the On Course I Workshop at Palomar College. During the summer of 2013, 32 of those faculty will continue to learn about how to successfully implement On Course strategies by attending the On Course II Workshop at Palomar College. A cohort of On Course-trained faculty has attended the On Course National Conference, where many faculty have given presentations about active learning. Palomar College faculty who have attended On Course workshops have also given a series of Professional Development workshops on campus to other faculty about incorporating On Course strategies into their courses.

Some of the challenges of infusing On Course principles campus-wide include resistance by faculty to new teaching strategies (even though they are proven to increase student retention and success) and the high cost of attending On Course Workshops to train faculty.

More details about On Course can be found at: http://www.oncourseworkshop.com/.
There is also an annual On Course National Conference (see: http://www.regonline.com/builder/site/default.aspx?EventID=1128944).
How On Course improves student retention and success rates is detailed here: http://www.oncourseworkshop.com/Data.htm

David H. Voorhees
Associate Professor Earth Science / Geology
Waubonsee Community College

The reason I became a geology instructor is that I want to instill the passion I have for the earth in my students. I want to be able to give to my students some of the understanding of how the earth works, because they are to become the stewards of this planet long after I am gone. I feel that I am not able to bring this passion and understanding to many of my students, and I continually try to engage all of my students, just as the geosciences engage all of them in their everyday lives. Most all effective instructors have a 'bag of tricks' through which they engage their students that evolves, as it should, as we get different populations of students in our classrooms. As most of my General Education, *Survey of Earth Science* students are millennials, engaging them is one of my biggest challenges as a geoscience educator. I have developed several ways that I think, bring to my students the nature of science, scientific inquiry, and along the way, make the content relevant to their lives. They fall into two groups: place-based-integration and mentoring.

Most 2YC students are place-bound to the county or region of that institution, and Waubonsee Community College is no exception. For that reason, I try to incorporate as much place-based information into the classroom as I can. I emphasize glacial landforms in terms of the landscape they have grown up on, and drive over every day; I discuss earthquakes and Earth History in terms of the nearby New Madrid Seismic Zone, tornadoes in terms of the monthly tornado siren test, etc. I would also suggest that bringing in current geological events that made the morning news, and relating them to content in class, brings relevance to the students. Recent examples include the nuclear bomb test in North Korea (seismology), the asteroid impact in Russia (astronomy & atmosphere), sinkhole collapse in Florida (groundwater & weathering), and major earthquakes in the Solomon Islands and Iran. In spite of the hard-core texters who are likely unengageable, I feel these discussions do bring relevance to the students, given the frequent follow-up questions from students.

Another method I bring place-based experiences to my students is with a series of exercises I call GeoScience Investigations (GSI) that I have added to my *Survey of Earth Science* class, and is worth 15% of the class grade. Students have to select 3 of 5 GSI exercises; 3 are on-campus simulated research experiences (place-based) in groups, and 2 are completed at home where the student works alone. They are designed and selected to provide as much opportunity for the student to become exposed to the nature of science; where data are collected, analyzed and interpreted. Anecdotally, the students generally do well on these exercises, and their class grades are favorably affected. Post-assignment survey's of the on-campus GSI's are generally favorable, but can be variable depending upon the particular aspects of a GSI (i.e., level of critical thinking, research conditions and protocols). Some are excited about their first exposure to scientific inquiry and the process of science, and some are not.

As many of my students enter my classroom unprepared for the rigors of a college education, part of my job is to mentor them. After the first class, I have all my students take a 15 question, multiple choice test on Blackboard, called the 'Syllabus Quiz'. Part of this is to make sure that all my students are aware of their responsibilities as college students, and my expectations of them. I also ask about their career goals and majors. I started this to identify geoscience 'majors', but I have discovered that it does begin to form bonds with non-geoscientists that have been helpful later in the semester, sometimes with Hispanic students. Waubonsee Community College is a Hispanic Serving Institution, and I am constantly challenged to learn new ways to reach my Hispanic students.

I have also added to my Survey of Earth Science classes 'Reading Quizzes', which are 15 multiple choice questions randomly selected from pools of up to 90 in Mastering Geology. These Reading Quizzes are to be taken by the student before lecture, and are on content covered in the lecture. Although I get several student comments about how they should be taken after class, I feel that they force students to develop appropriate study habits that will benefit them in their college careers.

Promoting Student Success using *Universal Design* to Decrease Barriers in Higher Education

Wendi J. W. Williams, PhD. / NorthWest Arkansas Community College / Division of Math and Science / wwilliams@nwacc.edu

I began teaching as a graduate student, and have since continued to grow in my understanding of content as well as educational design and delivery as faculty contributing to both 2-year and 4-year public institutions. Through the years I have become increasingly aware of the many kinds of diversity in my students: learning preferences, amount of college preparation, first generation college-bound, ages represented by concurrent enrollment as high school students through retirees, persons with disabilities, English language learners, and military active duty and/or veteran status. Early in my association with UA-Little Rock, Earth Science faculty joined a pilot program with the Disability Resource Center. "Project PACE" was funded by the U.S. Dept. of Ed and UALR to teach faculty to use Universal Design techniques in order to reduce barriers for the majority of students while increasing access to higher education. NCES (2013) indicates that students with some college courses or who achieve degrees become members of the workforce at higher rates. If redesigning our courses lower barriers, then our 2YC population benefits even more in the long term.

Universal Design (UD) can be summarized as three overarching principles covering multiple means of representation, action and expression, and engagement. Each of the three principles has three associated guidelines (CAST, 2011). UD guidelines naturally include many of the suggested "best practices" for learner-centered instruction as well as for English language learners, such as use of both visual and auditory media, incorporation of interpersonal strategies (cooperative learning, think/pair/share, jigsaw); designing course structure for applying consistent routines, "road maps" to science, and outlines; demonstrations; reading and writing (e.g. journaling); instructional techniques such as wait time and analogies; and vocabulary/concept strategies. My Project PACE training also included training through CAST (www.cast.org), DO-IT (http://www.washington.edu/doit/), and WebAim (http://webaim.org/).

My goal is as much to support my students' success in learning integrated science concepts as it is to foster each of them in learning more about the way they learn so as to promote their continued intellectual growth once they move on from my classroom or institution. The deliberate use of Universal Design with my classes brings strength to my teaching and I perceive its use as valuable, mainly due to its far-reaching implications. I work primarily with non-science majors, many of whom are in the early elementary to middle childhood tracks within teacher education. For many with identified or non-identified disabilities, it seems "too late" in the pipeline to make science accessible enough for them to want to major and select a STEM vocation. I continue to articulate that I am applying UD techniques, why I apply them and encourage my future teachers to do likewise as they develop their toolkits. I believe that by deliberately providing UD rationale and implementation, I best model what I desire them to take ownership of and apply in their own professional endeavors. But is it easy? Not initially, especially when I had to retrofit existing courses. Was it impactful *enough* in terms of numbers of persons served for the effort involved on my part? Now that I have been involved in UD for more than a decade, I am convinced it is well worth it in terms of impact. If we consider just one of the sub-populations such as students *identifying* themselves as a person with disability, the potential is large across the U.S. with approximately 770,000 people enrolled in 2- and 4-year institutions – and 50% of that demographic at 2YCs (Raeu and Lewis, 2011). The National Center for Educational Statistics conducted a survey in 2009 of higher education institutions (public, private, nonprofit, and for profit). Institutions responded to issues such as: limited staff resources to provide faculty and staff with training on accessibility issues, costs associated with appropriate technology, lack of incentives for faculty to change their instructional practices, and costs associated with incorporating Universal Design features into major renovation and new construction projects. Public and private nonprofit schools reported upwards of 40 % - 55% with barriers hindering implementation of Universal Design. Not surprisingly, 2YC institutions were on the upper end of that range.

However in as much as I embrace applying Universal Design, there are challenges to its implementation: time, funding and notifications. In terms of time, I am getting more modalities added to my courses incrementally otherwise doing the variety of recommended modes all at once can be overwhelming. What's making it easier now? In part, Society is "catching up." U.S. federal laws are tightening in terms of accessibility. The course management system I use for my hybrid and online classes now has a number of useful features (e.g. voice threads) or using inexpensive commercial software I can auto-transcribe lectures using voice recognition. Notification? This had been a big challenge until I started with UD, as faculty don't often learn that a student needs accommodation until the start of the semester or some time long into it… and that assumes students notify you at all (especially in an online format). Plus students have varying attitudes concerning notification and self-advocacy. So…all the more reason to develop curriculum and course implementation and management using UD: If you have done so effectively, then barriers have been diminished and there is no need for most eligible students to request an accommodation…since the barriers are not there to begin with!

At this point, I am not yet clear whether or not there are any quantitative studies providing evidence of the effectiveness of Universal Design in post-secondary geoscience education. There are publications for K-12 science (e.g. Howard and Potts, 2013) and I found a whitepaper summarizing a NSF-sponsored workshop for chemistry faculty (NSF, 2010), but I have been unable to specifically find any UD studies published for college-level geoscience courses. In the broader realm of UD applications however, I am aware of articles available through the Association of Higher Education and Disability (www.ahead.org). Roberts and others (2013) conducted a systematic review of empirically based articles concerning UD in postsecondary education. Their summary included qualitative, quantitative, and mixed methods documented in peer-reviewed journals since 2000, and resulted in very few papers identified (though this may be due to the lack of standardized lexicon within the UD community). Other recent articles through the Journal of Postsecondary Education and Disability by Humphrey and others (2012), Park and others (2013), and Schelly and others (2012) provide promising results, suggest professional development and classroom strategies, indicate increased faculty interest in commitment to reasonable and effective accommodations, and support the premise that use of UD may enhance experiences for all students. So, there appears to be an opportunity!

I am now ready to take the next step by collaborating with others to quantitatively explore specifically the efficacy of Universal Design in geoscience education. I have been asked to facilitate a break-out session during this July 2013 SAGE 2YC workshop, which I have labeled rather generally as "Students with Disabilities." I look forward to participating in a cohort of faculty with similar interests in Universal Design in order to expand future professional development, implementation and assessment. Universal Design has all the essentials of various "best practices" and "student-centered/learner-centered" techniques that are now much more ingrained in my way of knowing and doing (thanks to workshops through "On the Cutting Edge" and SAGE 2YC). Let's now broaden participation and formally access it!

References

CAST (2011). Universal Design for Learning Guidelines (Version 2.0). Wakefield, MA: Retrieved from http://www.udlcenter.org/aboutudl/udlguidelines

Howard, L. and Potts, E. (2013) Including Students with Disabilities in Advanced Science Classes. National Science Teachers Assoc Press, 131 pp.

Humphrey, M., Woods, L., and Huglin, L. (2012) PRACTICE BRIEF Increasing Faculty Awareness of Students with Disabilities: A Two-Pronged Approach. J Postsec Ed and Dis, 24 (3), 255 – 261.

NCES (2013) The Condition of Education 2013. Washington, DC: Retrieved from http://nces.ed.gov/pubs2013/2013037.pdf

NSF (2010) Workshop on Excellence Empowered by a Diverse Academic Workforce: Chemists, Chemical Engineers, and Materials Scientists with Disabilities, Arlington, VA. Retrieved from http://www.nsf.gov/mps/dmr/BroadeningPresentations/Patel_NSFDisability_LayoutFinal2.pdf .

Park, H., Roberts, K., and Stodden, R. (2013) PRACTICE BRIEF Faculty Perspectives on Professional Development to Improve Efficacy when Teaching Students with Disabilities. J Postsec Ed and Dis, 25 (4), 377 – 383.

Raue, K., and Lewis, L. (2011) *Students with Disabilities at Degree-Granting Postsecondary Institutions* (NCES 2011–018). U.S. Dept Ed, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

Roberts, K., Park, H., Brown, S., and Cook, B. (2011) Universal Design for Instruction in Postsecondary Education: A Systematic Review of Empirically Based Articles, J Postsec Ed and Dis, 24 (1), 5 – 15.

Shelly, C., Davies, P., and Spooner, C. (2012) Student Perceptions of Faculty Implementation of Universal Design for Learning, J Postsec Ed and Dis, 24 (1), 17 – 30.

"Never doubt that a small group of committed people can change the world. Indeed, it is the only thing that ever has."
Margaret Mead

Tracking the Pathways of Students During Their Transition to the Early Career Workforce

Carolyn Wilson, Workforce Data Analyst
American Geosciences Institute

The Workforce Program at the American Geosciences Institute has developed the National Geoscience Student Exit Survey in order to determine the relevant experiences in undergraduate and graduate school, as well as the immediate career plans of students finishing their bachelor's, master's, or doctoral degrees in the geosciences. Specifically, the survey addresses the students' education background, decision points for obtaining a geoscience degree, their geoscience co-curricular experiences, and their future plans for either entering graduate school or entering the workforce immediately after graduation. This work will begin to highlight the sets of experiences and expertise that the typical student graduating with a geoscience degree gained, as well as the industries that are effective at recruiting and the industries where students want to gain employment. Over time there may be some regional differences in these areas, along with differences based on the students' areas of focus for their degree. AGI's National Geoscience Student Exit Survey has been through a two-year piloting phase, and it was recently made available to any undergraduate or graduate department in the United States for spring 2013 graduates.

This survey will be followed up with a second longitudinal survey effort that will look closely at the career paths of early career geoscientists. Recent graduates will have the opportunity to take this survey yearly for the first 5-7 years in the workforce, and they will provide responses to questions about their current job position, location, salary information, and skills gained while in the workforce. This survey will be able to provide a profile of the early career geoscientist, as well as identify the industries that are able to retain these new members to the workforce for an extended period of time. This survey came about due to concern of a high percentage of attrition of new geoscientists from the geoscience workforce after one or two years in the workforce. This survey will begin collecting data this summer.

As these two surveys gain more awareness in the geosciences community, I would like to being offering the Exit Survey to students at 2-year institutions. Some minor modifications may need to be executed before rolling it out to 2-year institutions. One of the major challenges I am dealing with in regards to these surveys is obtaining department participation. While many departments agree to participate and see the merit in this study, there is still difficulty encouraging students to participate. Before arriving to this meeting, I will have been able to review some of the major data points of this most recent data collection for the Exit Survey and would be happy to talk to anyone about my preliminary findings. If you have any questions about these surveys, or would like to discuss the modifications of the Exit Survey for 2-year institutions, please feel free to contact me at cwilson@agiweb.org.

Supporting Student Success in Geoscience at 2YCs through Field Based Learning

Ben Wolfe
Metropolitan Community College – Kansas City

The overwhelming majority of students at my institution take geoscience courses (e.g. physical geology or physical geography) to fulfill part of the general education requirements of the Associates in Arts degree or General Education certificate for transfer to a 4-year school. I face many challenges teaching introductory geoscience education which include few students with geoscience-related interests or majors, difficulty in finding effective, exciting, and engaging ways to teach basic scientific principles, as well as teaching to students who often have negative pre-conceived notions of science and low motivation in engagement with science related content. To support and increase student interest, success, and retention in geosciences courses, I have developed and maintained a very active field-based learning program at MCC - Kansas City designed specifically for non-science majors. These field-based learning activities varying from laboratory exercises, out-of-class student projects, local day trips, to an 11-day extended interdisciplinary field study course.

I have found incorporating field based learning, such as field trips (a local road cut, stream clean-up, or waste-water treatment plant visit), field-oriented class activities (geocaching, outdoor relative humidity lab, or even tree coring on campus – note, always talk to your grounds keepers first!), and longer field-based courses in an introductory science curriculum is a key component to making geoscience concepts stimulating and engaging to students. I have designed field based learning curriculum to link earth sciences and life sciences concepts and provide opportunities for students to apply such concepts to “real life” situations. Curriculum for field based learning also focuses on improving critical and higher-order thinking skills which enables students to put into practice the scientific inquiry method. To promote an active and engaging learning atmosphere, field based activities are designed to give students the opportunity to practice science in a hands-on environment where students actually “do” science. This facilitates learning science and refines observation skills beyond a set of laboratory exercises and classroom lectures. Field based activities are inquiry based and students are encouraged to ask questions, develop hypotheses, and to make observations to find the answers to their questions. Field studies also have the added benefit of exposing students to environmental and conservation issues that may stimulate student interest and significance for their own lives.

To measure the effectiveness of field-based learning I have administered student experience surveys at the conclusion of the courses or field studies, as well as interviewed selected trip participants to capture student perceptions of effective learning aspects of field based learning. I have also compared student experience survey results with the same student experience survey administered in sections of an introductory physical geology course. Survey results show statistically significant higher student value placed on field-based learning than in a traditional lecture/lab course. Interview results show student perceptions value hands-on learning and place-based education that field-based learning provides.

There are many challenges faced in attempting to develop a field based learning program. Of course, close relationships with and building buy-in from administrators, deans, and risk-management personnel is critical. The largest hurdle I have had to overcome is the reams of paper required for release forms and travel requests and more importantly, the costs inquired with field study courses. Unfortunately, most of the cost must be passed onto the students, which in turn has impacted the number of students enrolled. Additionally, students find it difficult to commit to an 11-day trip, especially those employed while attending school. I continue to search and struggle to find ways to make such trips as inexpensive to students as possible.