Incorporating Student-Led Field Trips and Learner-Centered Teaching in a Capstone Geology Course

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ABSTRACT

Capstone experiences are typically the culmination of an undergraduate program and allow students to integrate their content knowledge with communication and technical skills, many of which are desirable in the job market and graduate school. Learner-centered teaching fits well with a capstone course because it requires students to be more engaged in the material and take an active role in their education. The capstone course in the University of Pittsburgh at Johnstown Geology program has recently been revised to include more learner-centered teaching and a Spring Break field trip. Each student in the course chose and led a field trip that illustrated a specific geologic feature or process. The majority of assignments for the course revolved around preparing, leading, and reporting on the field trip topic. The students generally enjoyed the course, found it beneficial, and learned geologic content because of their own inquiry. By shifting the course to emphasize learner-centered teaching, the students were more prepared for assignments, applied and enhanced their geologic content knowledge, gained exposure to new geologic settings, improved their communication skills, and bonded with their classmates. © *2012 National Association of Geoscience Teachers*. [DOI: 10.5408/11-255.1]

Key words: capstone course, field trip, learner-centered teaching

Introduction

Undergraduate geology education can be strengthened through increased emphasis on field experiences and learner-centered teaching (or student-centered learning) (Marvell, 2008). Field experiences are a critical component of a solid foundation in the Earth sciences (Kent et al., 1997; Whitmeyer et al., 2009) and are often a required component of undergraduate geology curricula. Learner-centered teaching transforms students from passive receivers of information to active learners, and has gained the support of various organizations such as the National Science Foundation (1996), the National Research Council (Bransford et al., 2000) and the Association of American Colleges and Universities (2002). This paper presents one possible way to combine meaningful learner-centered teaching with field experiences in a capstone geology course.

Traditionally, undergraduate-level field trips are led by faculty members to introduce new geologic terranes, convey knowledge, and illustrate fundamental concepts. Students might have the opportunity to collect limited amounts of data (e.g., strike and dip) on such field trips, but students might largely be passive learners, despite the field setting. To take a more active role in their field education, students can take on the responsibility of leading portions of a field trip and become active learners, for at least the students' portion of the field trip. The inclusion of field experiences, especially student driven, builds confidence in students and increases their conceptual understanding of the topic at hand (Hemler and Repine, 2006; Gonzales and Semken, 2009).

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Course Background and Rationale

The capstone course in the University of Pittsburgh at Johnstown (Pitt-Johnstown) geology curriculum is GEOL 1108: Report Writing and Computer Applications in Geology (hereafter referred to as "Report Writing"). This course has been designated as "Primary Writing" and "Speaking Enhanced"; students in the Geology program at Pitt-Johnstown must complete one Primary Writing course (in addition to English Composition 1 and 2) and three Speaking-Enhanced courses (or one Speaking-Enhanced and one Primary Speaking course). Among the requirements for Primary Writing courses, students must receive substantive feedback on the content, organization, clarity, and grammatical correctness of their writing, as well as complete written activities and assignments throughout the semester. Speaking-Enhanced courses must include at least two speaking experiences, one of which must be an individual oral presentation, which is graded with written feedback on presentation style and content (see "Oral Presentation Rubric" in the online supplemental material. Available at: http://dx.doi.org/10-5408/11-255s1.)

The Report Writing course was redesigned in Spring Semester 2009, with the stated objectives that students will improve their writing skills, have increased comfort conducting research through scientific literature, prepare and give a professional-style talk, create and present a poster at the campus undergraduate research symposium, and gain additional skills with common software packages. The focus of the redesigned course was a Spring Break field trip in which each student was responsible for leading a half- to full-day component, with multiple stops in an area of geologic interest. To meet the stated goals, most course assignments related directly to the field trip. Prior to 2009, the course had been taught as a series of discrete assignments, with little to no relation to one another (e.g., find and summarize a scientific article, use PowerPoint to give a presentation on a topic of your choice). Setting the field trip as the central theme of the course gave additional relevance to the associated

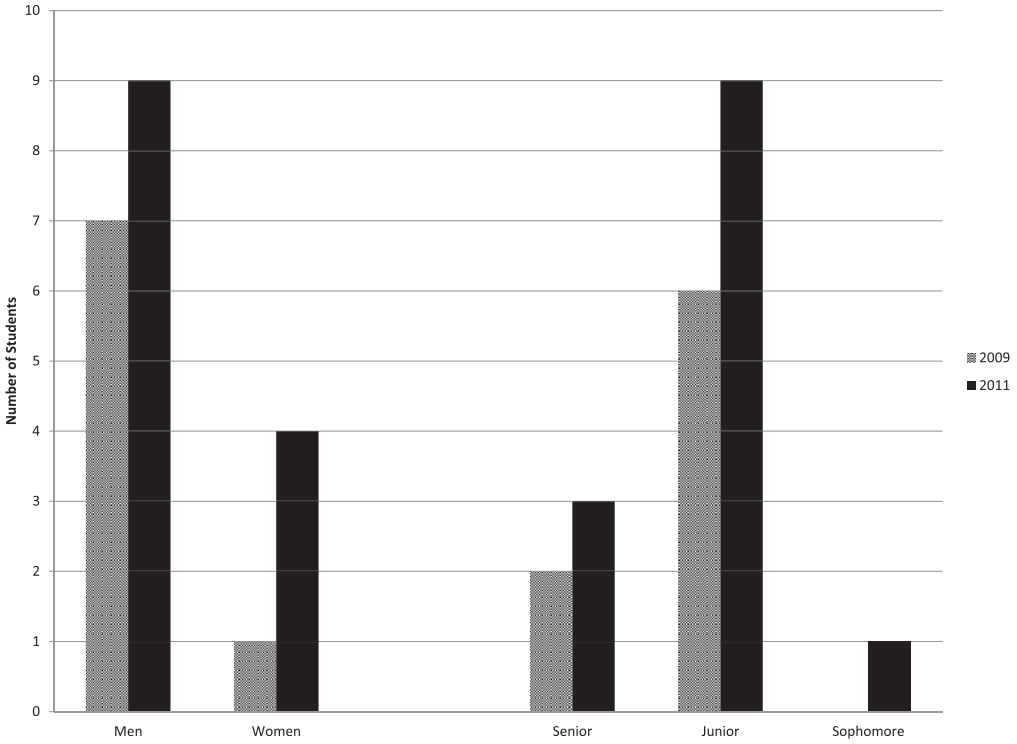

FIGURE 1: Course demographics for 2009 and 2011.

assignments (e.g., find and summarize a scientific article related to your chosen field site, give a PowerPoint presentation on the geologic setting of your chosen field site). The course was offered again in the Spring Semester 2011 by a different instructor, but with the same goals and objectives as the 2009 offering. This second offering allowed the instructor to learn from the first offering, improve weaknesses, and enhance successful endeavors.

Demographic Information

Ten students were enrolled in the 2009 Report Writing course, although only eight were able to participate in the Spring Break field trip (see "Additional Considerations" section for accommodations made for these two students). All 13 students taking the 2011 course participated in the Spring Break field trip. The course is open to any geology major who has completed the introductory course sequence (Physical Geology and Historical Geology), although we encourage students to wait until junior or senior year in order to have more geology courses completed. In both 2009 and 2011, there were more juniors than seniors, and more men than women (Fig. 1). All students were white and from Pennsylvania, which is representative of the campus (Fig. 2). The gender ratio is slightly skewed toward male students in the Report Writing course, which is more indicative of the geology major at Pitt-Johnstown than of the campus gender ratio.

Course Elements

During the first week of the semester, students discussed possible field trip destinations and estimated expenses associated with potential locations. The 2009 cohort selected the southwestern U.S. as their destination (Nevada, Utah, and eastern California), while the 2011 cohort chose the southeastern U.S. (West Virginia, Virginia, and North Carolina). Once the general destination was decided, each student was responsible for selecting a smaller area (one to five sites) of personal geologic interest in this region. This required searching the scientific literature to gain an understanding of the geology of the region and the specific geology of their sites. Students gave preliminary presentations to their peers prior to the trip. These presentations included general site information, geologic setting, and preview of what the class could expect to do at the sites. Constructive feedback from classmates and the instructor was given via written comments and a class discussion immediately after the presentations. The class then worked together to create an itinerary, complete with estimated travel times and overnight stops, for the allotted time over Spring Break. During this stage, a few potential sites were dropped and others added to cluster the sites and minimize drive times. After instructor approval of all sites, students continued their pre–field trip geologic research, as well as developing a list of pertinent questions to ask/investigate at the sites and a list of photographs to take at the sites to illustrate specific geologic features (see syllabi in the online supplemental material. Available at: http://dx.doi.org/10.5408/11/255S2 and http://dx.doi.org/10.5408/11/255S3). These pre–field trip preparations encouraged the students to gain a deeper understanding and plan of what they expected to do at each of their sites. Prior to departure, each student assembled a road log with driving directions, global

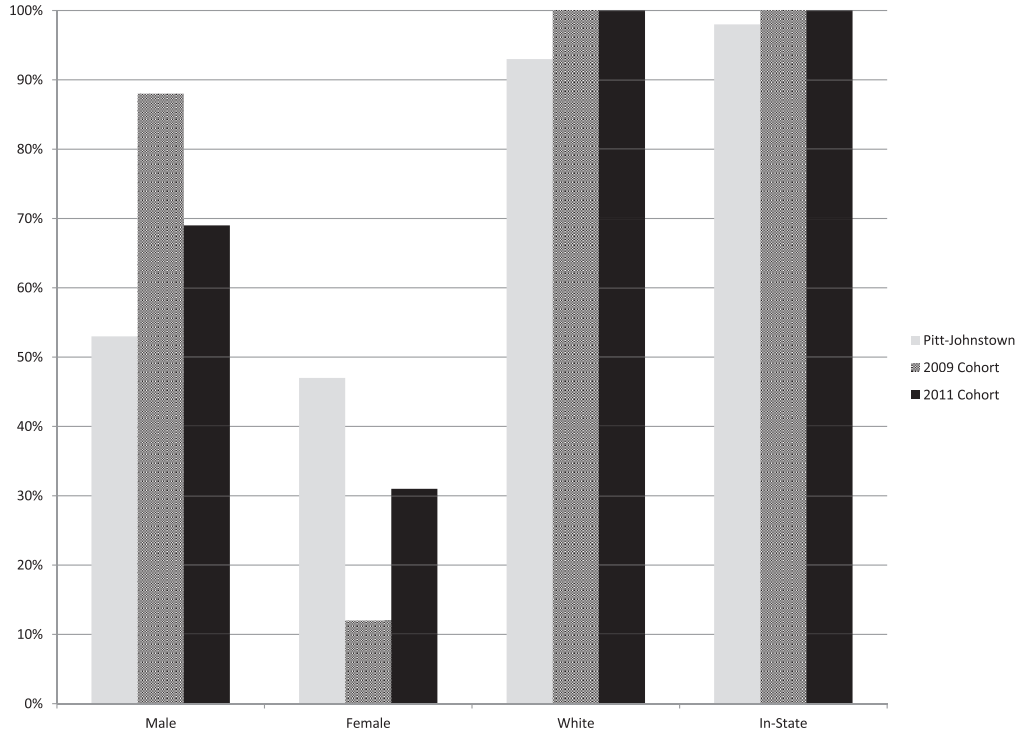

FIGURE 2: Course demographics compared with Pitt-Johnstown population (University of Pittsburgh, 2009).

positioning system coordinates, and maps of the student's site(s).

Students were also responsible for acquiring any waivers for entrance fees, making agencies/landowners aware of our presence, getting permission to remove samples (if necessary), and securing overnight accommodations. The 2009 class camped all but two nights, while the 2011 class stayed exclusively in motels (most campgrounds in the southeast were not yet open). The 2009 class planned menus, did the food shopping, and cooked the meals at the camp sites, as well as created a schedule for cooking and other camp duties (cleaning dishes, packing vans, etc.) to maximize efficiency. Meals were less of a burden for the 2011 cohort, as every motel provided a continental breakfast at minimum, and dinner was of their choosing at local restaurants. The students were responsible for buying lunch supplies for the group, and every morning a lunch was packed by each student. Two nights were spent in a cabin, which required preparing additional meals, which the students were happy to do because it provided a break from restaurants and fast food. Each student also had a van-specific task, such as removing trash, pumping gas, and washing windows, which occurred each time the van stopped. The field trip itself served as a social learning experience because it required advance preparation, logistical considerations, data collection, cooperation, improvisation, and much effort (Heffernan et al., 2002).

Each student's field trip component was to consist of multiple stops at which the student would present the geologic background, setting, and any other important information. Many students used the available labor of their classmates to collect data, such as water quality, at their field stops. The stops were related to an overarching theme selected by the student, although there was no theme for the entire trip (Table I).

The completion of the field trip was not the end of the project, however. Both cohorts used the remainder of the semester to create and present a poster at the campus undergraduate research symposium (The University of Pittsburgh at Johnstown Symposium for the Promotion of Academic and Creative Enquiry) and assemble a single geologic field guide for the entire Spring Break trip. Since most of the students had little-to-no experience with formal geologic field guides, field guides from various organizations such as the New England Intercollegiate Geologic Conference and the Field Conference of Pennsylvania Geologists were provided as examples. The 2011 course was slightly revised to include two additional post–field trip assignments, a formal in-class presentation in the style of a Geological Society of America talk on their individual field sites and a scientific research paper on the theme of their field sites, with examples drawn from the field trip. These final assignments provided wrap-up and allowed for critical reflection on the field trip. The entire geologic field guide from 2011 is available as online supplemental material. (Available at: http://dx.doi.org/10.5408/11-255S4).

Additionally, a blog (http://mountaincatgeology.wordpress.com) was established in 2009 for students to share their geologic experiences and practice writing in a less formal setting. Both instructors required students to make a minimum of 10 blog entries throughout the semester. The blog assignments were not graded for content, spelling, or grammar; rather, students were simply given credit for completion. While occasional writing prompts were given

Table I: Itineraries for the 2009 and 2011 Report Writing Spring Break field trips.

Day	2009	2011
1	Depart campus Fly to Las Vegas, NV Overnight: St. George, UT	Depart campus Trip 1: Erosional and depositional features of Blackwater Falls S.P., WV Overnight: Winchester, VA
2	Trip 1: Erosional features of Zion National Park, UT Overnight: Valley of Fire State Park, NV	Trip 2: Igneous structures of Shenandoah National Park, VA Trip 3: Ordovician limestone of Luray Caverns, VA Overnight: Luray, VA
3	Trip 2: Stratigraphy of Arrow Canyon, NV Trip 3: Relationship between hydrology and structural geology in Valley of Fire S.P., NV Overnight: Valley of Fire S.P., NV	Trip 4: Catoctin Formation in Shenandoah N.P., VA Trip 5: Mass movements in Craig and Giles Counties, VA Overnight: Hillsville, VA
4	Trip 4: Fossils of the Willow Tank Formation, NV Trip 5a: "Great Unconformity" at Frenchman Mountain, NV Overnight: Lake Mead N.R.A., NV	Trip 6: Metamorphic rocks in the Grandfather Mountain area, NC Trip 7: Linville Falls waterfalls and thrust fault, NC Overnight: Waynesville, NC
5	Trip 5b: Sedimentary Sequences of the Potosi region, NV Trip 6: Ubehebe Crater, CA Overnight: Death Valley N.P., CA	Trip 8: Igneous features of Looking Glass Rock, NC (canceled) Trip 9: Geologic terranes along the Blue Ridge Parkway, NC (canceled) Overnight: Waynesville, NC
6	Trip 7: Erosional features of Death Valley, CA Trip 8: Structural geology of Death Valley, CA Overnight: Death Valley N.P., CA	Travel day Overnight: Morehead City, NC
7	Side trip to dune fields in Death Valley Overnight: Las Vegas, NV	Trip 10: Hydrology and soils in Croatan National Forest, NC Trip 11: Evidence of sea level change in the Neuse River, NC Overnight: Kill Devil Hills, NC
8	Depart Las Vegas Fly to Pittsburgh Return to campus	Trip 12: Control of nature in the Outer Banks, NC Trip 13: Geomorphology of the Outer Banks, NC Overnight: Kill Devil Hills, NC
9		Return to campus

(e.g., "Why did you become a geology major and what do you most enjoy about geology?" or "Pick a current event article found in the mass media. Summarize the article and provide your own insight/opinion about the topic."), most students were able to successfully blog with no additional input, and many used this opportunity to seek input on their selected location from the greater "geoblogosphere" and reflect on the field trip.

Inclusion of Learner-Centered Principles

Unifying course assignments around the Spring Break field trip was one of two major changes made to the Report Writing course. The pedagogy of the course also shifted to have an increased emphasis on learned-centered teaching. In learner-centered teaching, the students are more engaged in the material because the instructors become facilitators of student learning, rather than distributors of content (Blumberg, 2009). National organizations have recognized the importance of shifting away from instructor-centered teaching to learner-centered teaching at the collegiate level. The redesigned Report Writing course met Blumberg's five dimensions of learner-centered teaching:

- Students as active and independent learners: The field trip allowed students to apply their knowledge and question their interpretations. Each student was responsible for leading a portion of the trip, which included gathering a variety of information (not dictated by the instructor), answering questions, and assembling a geologic history of the area.
- Instructor as facilitator of student learning: Relatively little information was directly disseminated by the instructor; rather, students were guided by the instructor as to where information could be found, what type of information was necessary, and how to integrate multiple sources.
- Shifted responsibility of learning from instructor to students: The instructor created situations and assignments that helped students use important tools (e.g., databases, geographic information systems) and motivated students to be responsible for their own learning. Each tool was applied as needed to the students' projects. Students were responsible for collecting and synthesizing sufficient information to lead their field trip, give presentations, and write papers.
- Assessment through constructive feedback: The instructor provided detailed written and verbal feedback

on assignments. Peer evaluation was also used to give additional feedback to students on papers and presentations. The use of peer evaluations not only provided comments that students could use in the development of their own work, but also provided experience in giving constructive feedback, which was a new task for some students and was a learning opportunity itself.

- Collaboration among students and instructor on course decisions: Students were responsible for selecting the general field trip destination, as well as their own field trip locations, and coordinating the stops and overnights with one another. The students also worked together to link each other's road logs, trip sites, and write-ups for the final field guide. Additionally, the 2009 cohort collaborated by planning menus and assigning camp duties.

By meeting these learner-centered principles, the Report Writing course was securely grounded in learner-centered teaching theory and provided ample opportunity for students to learn in an environment somewhat different from many of their other, more traditional, courses.

The psychological basis for how students learn also supports the adoption of learner-centered teaching and has been summarized into five main principles (Alexander and Murphy, 2000). These principles are useful in understanding the importance of a shift to learner-centered teaching. The five learner-centered principles identified by Alexander and Murphy (2000) are listed below, as well as how elements of the Report Writing course coincided with these principles:

- Knowledge base: Students were able to construct and build on their existing knowledge of a chosen geologic setting, and create links between prior knowledge and information gained through research and the field experience.
- Strategic processing and executive control: Students achieved strategic processing and executive control (metacognition skills) through weekly blog assignments and periodic reflective discussions.
- Motivation and affect: Much of the course progressed because of student motivation and commitment to the project. The students chose the general region for the field trip, as well as their individual field stops within that region, which also increased personal interest and motivation to study their particular sites. Students seemed to take ownership of their location and the education of their classmates. Many students worked ahead of schedule because of deepening interest in their location.
- Development and individual difference: Because of the varied format of the course and the ability for students to work independently, students were able to work to their strengths and learn based on their own preferences. Weaknesses were addressed and corrected through individualized attention and feedback from the instructor.
- Situation/context: This was emphasized through group discussion and subsequent development of a collaborative field guide, but was most notable because of the learning that occurred during the shared social experience of the field trip.

Students can be resistant to learner-centered teaching because it requires more effort on their part, and the instructor does not always have a predetermined answer ready. By putting the learner-centered teaching in a context, such as the field trip, the students can readily recognize the importance of being more engaged with the material and that it is impractical for the instructor to provide all the information to the class. Student learning and engagement increase when students take control of their own education (Weimer, 2002).

Outcomes

While no formal pre- and post-assessment was conducted for either cohort, both instructors observed a number of positive learning outcomes by the end of the semester, which were also reflected in the course evaluations. On the official course evaluations, students indicated by a numerical score (3.75 out of 5) that they learned "much more" than in other courses and that they would "definitely recommend" this course (5 out of 5). Some comments from the 2011 course evaluations (in response to the question, "What aspects of the course were most beneficial to you?") included:

> *"The whole course was beneficial. I can read scientific papers better and understand [them]. I'm more confident with presentations."*

> *"Completing a field trip and planning/preparing everything was really stimulating. Getting everyone prepared for the future."*

> *"It is a very hands-on kind of class, which helped with learning the content."*

> *"Learning how to research an area and then, with that knowledge, guide a field trip of that location."*

Additionally, an informal survey was given to the students after the semester ended in order to assess their reflections after the completion of the course (formal, university-administered course evaluations are typically given two-thirds of the way through the semester). The results of this survey indicate that the students enjoyed the field trip and understood the material better in the field context, gave more effort to their field trip component than a "normal" assignment, and preferred the geologic focus of the speaking and writing assignments (Table II).

The students learned a great deal from their own research, but they also seemed to learn well from their peers. Both cohorts displayed respect toward the current field trip leader and fully participated in each field trip by hiking the requisite distance, collecting the data specified by the leader, and asking and answering questions about the location. The increased participation could be a reflection of the students' recognition of the amount of work each put into their

Table II: The following questions were asked in an informal, post–course survey to students in both cohorts. Fourteen students (total) completed the survey (4 from 2009 and 10 from 2011). Because of the similarity of answers between the cohorts, the responses have been aggregated.

Survey question	Average response[1]	Selected student comments
A field trip is the best way to learn about unfamiliar geologic regions.	Strongly agree (4.6)	"You can read all about the rocks, but seeing the rock in person helps complete the understanding of the research subject not to mention adds credibility to the presenter."
Having a geologic-focused writing and speaking course made me more comfortable with the writing and speaking component than a course from another department.	Agree (4.1)	
I would have preferred to take writing and speaking courses taught in the English or Communication Departments rather than a geology-focused writing and speaking course.	Strongly disagree/disagree (1.5)	
I did not get enough out of the field trip to justify giving up my Spring Break.	Disagree (1.9)	"I was originally opposed to the idea mainly on financial reasons . . . however, I had a lot of fun on my geology trip."
My ability with scientific writing improved as a result of this course.	Agree (3.8)	
This course made me feel like a "real geologist."	Neither agree nor disagree (3.4)	
I would recommend the use of student-led field trips in future offerings of this course.	Agree (4.4)	"This was a really awesome class."
Because I was responsible for educating my peers in the field, my desire to know the material was higher than for an in-class PowerPoint presentation.	Agree (3.8)	
Visiting the field sites helped me to better understand the literature I read about the site.	Agree (4.3)	"It was very helpful to go visit the sites and actually be able to see what we were researching and to teach it to other students."
This course was a geology "capstone" course, meaning that it required me to apply content knowledge and skills learned in other geology courses.	Agree (4.1)	"In theory I would agree, but my research was geomorphology-based, which I never took as a course."
After this course, my ability to read and understand scientific literature was:	Somewhat improved (3.8)	
Compared to a "normal" assignment, having "ownership" of a field trip made me give:	More effort (4.4)	
Having multiple assignments about a specific geologic location made me:	More interested in the assignments (3.6)	". . . it gave a structured outline to work from, which allowed me to stay on track with the research, which in turn allowed me to discover other interesting aspects of my assignment."
Compared to an assigned research topic in other courses, selecting my own field trip stops made me:	More interested in conducting research (4.4)	"It allowed me to pick an aspect of geology that I was personally interested [in], which also made the research much easier."
After completing the course, my relationship with my classmates was:	Better/much better (4.5)	"It was a really good bonding experience with the entire class. Everyone worked well together and cooperated."

[1]Points were awarded based on the possible responses. Most questions were based on the following 1–5 scale: 1, strongly disagree; 2, disagree; 3, neither agree nor disagree; 4, agree; and 5, strongly agree. The remaining questions also used the same point value, with the more positive responses receiving higher values and the more negative responses receiving lower values.

individual field trip portion and an attitude of mutual respect.

Advance Preparation

In contrast to in-class presentations, the students needed to prepare much further in advance to successfully lead their respective field trips. The 2009 class had virtually no Internet access over Spring Break and could not perform last-minute research; the 2011 class did have Internet access every night (and more students had "smartphones" than in 2009), but very few students used this increased connectivity to "cram" for their presentation. The interim deadlines set prior to the excursion also encouraged preparation well in advance of departure (Table III). By the time the students visited their field sites for the first time, most had conducted sufficient research to immediately recognize features and begin the presentation. A few students did need some time (less than 15 min) at the site for reconnaissance before starting their presentation. It also seemed that since students were responsible for educating their peers and were expected to answer questions in the field, most students went beyond gaining the minimum amount of knowledge in order to be very well prepared. Students sought information from a variety of sources including *U.S. Geological Survey* publications, scientific journal articles, field guides, unpublished theses, Web sites, and books.

Application and Enhancement of Geologic Content Knowledge

Students applied their existing geologic knowledge to their field sites and deepened their knowledge through research before and after the trip. Because of the alternate-year offering of this course, some students were at the end of their undergraduate careers and had completed their geologic education, while other students were juniors and had taken fewer geology courses to date. The individualized nature of the projects and research allowed each student to learn at his/her own pace and focus attention onto the topics as they saw fit. For example, one student selected a field site that illustrated a thrust fault in metamorphic rocks, despite not having coursework in Structural Geology or Igneous and Metamorphic Petrology; this student read extensively and sought help with the unfamiliar and difficult concepts. Other students selected locations at which they could apply knowledge learned in their favorite geology courses, such as the student who searched exclusively for sites that showed various types of soils because of her enjoyment of a Geology of Soils course. Regardless of the topic, every student's geologic knowledge was expanded because of the project. Building on existing knowledge, and linking new information and experiences are integral to the constructivist philosophy and have been shown to increase retention and understanding of course material (Blumberg, 2009).

Two students from each cohort continued their studies with research projects on their selected field trip area. The ability to pick a topic of interest and explore it in detail gave these students a good background for a senior research project. Visiting the sites and collecting data over the trip provided some of the information necessary to begin an in-depth research project.

Exposure to New Geologic Regions

A critical impetus to center the Report Writing course on a Spring Break field trip was the chance to expose the students to a wider range of geologic settings. All students taking the course were from Pennsylvania and had spent the majority of their previous field experiences in the sedimentary rocks of western Pennsylvania. Both field trips provided very different geologic settings, from the Quaternary deposits of the North Carolina coastal plain to pre-Cambrian igneous rocks of Virginia and from the Great Unconformity in Nevada to the volcanics of Death Valley. Very few students had visited any of the locations prior to the trip, and those that had had done so as a tourist, not as a geologist. Seeing aspects of geology in the field for the first time enhanced the students' experiences, and many expressed pure enjoyment of seeing geologic features firsthand, about which they had only previously read. This also seemed to increase participation, curiosity, and learning at each site.

Improved Communication Skills

Students' communication skills noticeably improved over the course of the semester. All students became clearly more comfortable giving oral presentations because of the increased emphasis on speaking and the number of speaking assignments. The 2011 course had at least 10 assigned speaking assignments. The instructors felt that students' writing skills also improved over the semester. Students who initially struggled with writing benefitted from multiple opportunities to revise and gain feedback on their papers. Improvement was also seen in the more proficient writers, who became more polished and "scientific" in their abilities. Students also felt their communication skills improved, as evidenced by their comments on course evaluations (see above).

Increased Camaraderie

Although not a specific goal of the course, the field trip experience served to build camaraderie within each cohort. Despite having many previous classes together, the students were not particularly "bonded" before the trip. The class dynamics were noticeably altered after the field trip, and the students indicated on the survey that their relationship with their classmates was better to much better after the field trip (Table II). Field experiences and extensive travel provides a common theme in which shared experiences provide the basis for friendship. The students' enthusiasm for the field trip and the availability of "down time" created a fun and playful environment, which can be conducive for learning (Jarrett and Burnley, 2010).

Additional Considerations

In the 2009 course, two of the 10 students completing the course were unable to participate in the Spring Break field trip because of valid prior commitments (one was a student athlete whose team had games scheduled over Spring Break, and one was participating in an overseas research excursion with another faculty member). The student athlete conducted a local field trip that met the requirements set for the rest of the class, and the other

Table III: Course schedule related to Spring Break field trip.[1]

Week	2009 Assignment schedule	2011 Assignment schedule
1	Preliminary field trip topic	General location decided
2	Annotated bibliography	Preliminary field trip topic
3	Preliminary presentation	Preliminary presentation
4	List of proposed stops	List of proposed stops
5	Road log, geologic map, Google Earth image of proposed trip	Annotated bibliography
6	Geologic background	List of stops with background geologic information and map
7	Data and interpretations, methods	Written proposal explaining relevance of each stop and illustrating a theme among chosen stops
8	List of outstanding questions and pictures to take	Written plan for each stop (includes list of questions for class, specific things to see, and pictures to take)
9	Road log, outcrop description	Road log
10	Spring Break Trip	Spring Break Trip
11		Revised road log
12	Field notes, revised road log	Final field guide
13	Abstract, introduction, conclusions Draft of poster	Rough draft research paper
14	Revised geologic background, methods, data and interpretations Posters (to Print Services)	Posters (to Print Services)
15	UPJ SPACE[2] poster presentation Revised outcrop descriptions All figures with captions	UPJ SPACE poster presentation Final oral presentation
16	Final field guide	Final research paper

[1]The 2011 class had two distinct writing assignments based on their field locations, a field guide with road log and stop descriptions, and a formal scientific research paper. The 2009 writing assignment combined the research element into the field guide.
[2]UPJ SPACE = The University of Pittsburgh at Johnstown Symposium for the Promotion of Academic and Creative Enquiry.

student conducted a virtual field trip of sites visited during the research excursion to Indonesia. Both students participated in all remaining aspects of the course.

Road conditions were a problem for both classes. In 2009, poor road conditions prevented the access of one part of a student's field trip; in 2011, weather-related closure of the Blue Ridge Parkway scuttled two students' field trips. Both 2011 students made up the trip by selecting new sites close to campus and conducting their field trips during laboratory sessions after Spring Break. The compression of time for the two make-up field trips meant that these two students did not spend as much time on their locations, but still participated in all aspects of the course. In 2009 and 2011, the road conditions were unforeseen and could not have been fully predicted. It is important to have a contingency plan in case of road closures or other circumstances that could prevent access to field sites. Although this was an unfortunate experience for the students, it became a learning opportunity, as even seasoned geologists have had their field plans impacted by external forces requiring improvisation.

Securing enough drivers for the course could be a problem, as the number of students and availability of vans changes. The 2009 class was split between two minivans, with the course instructor driving one and another faculty member driving the other. This required giving up Spring Break by the faculty member. Because rental vans were used and no students were over 25 years old, all 10 people, the food, and all camping gear fit into two minivans. The 2011 class was larger and required three rented minivans, as all campus-owned vehicles were previously reserved by other groups. The instructor drove one van, an over-25 student drove another van, and a non–Geology faculty member drove the third van because no other Geology faculty members were available over Spring Break. The student driver carried a much greater responsibility than other students did in the course; it would be nice to have additional drivers so that one student does not bear the responsibility of full-time driving.

A key component in the success of these extended field trips was the fund-raising efforts by the students. The 2009 trip cost each student approximately $250 (plus any personal expenses, such as souvenirs) and the 2011 trip cost each student around $150 (plus any personal expenses). The higher cost in 2009 reflects the students' choice to fly to the field trip region, while the 2011 trip region was selected because it was within driving distance of campus. Lodging costs in 2011 were minimized by putting three to four people

per room and selecting the least-expensive motel available. Additional financial support came from the Geology Club and to a lesser extent, the Pitt-Johnstown Division of Natural Sciences.

Conclusion

Geology remains a field-based science in which communication is important. Students graduating with a geology degree should have experience with and be comfortable with both. The inclusion of a student-led extended field trip in an undergraduate capstone course required students to perform the necessary background research and analysis to understand a new area in sufficient detail to present a coherent field trip to classmates. Effective communications skills also made the expression of geologic information possible. This paper describes a capstone course that had been redesigned to include student-led field trips and communication-enhancing activities in a learner-centered environment in which students were actively engaged in their education.

The shift from instructor-centered to student-centered learning enhanced the Pitt-Johnstown Report Writing course in 2009 and 2011. Students developed and applied geologic knowledge in this course, rather than repeating information provided by the instructor. In order to have a successful field trip, each student needed a deep understanding of their field stops to effectively explain the geologic setting, processes, and specific features of their sites. Communication skills were also enhanced through a number of written and oral assignments, and feedback from the instructor and classmates. By emphasizing student learning rather than instructor-provided material, the students took ownership of their education, were more engaged in the course, and gained important life skills.

This model could be transferred to other courses in geology, such as a geomorphology course, in which each student selects a different landscape feature to investigate, or to a scaled-down version, in which students lead local field trips during laboratory time or even on campus. The value of this particular course model is the combination of conducting background research, giving field-based and formal class presentations, writing a geologic guidebook and technical report, and enhancing existing while creating new geologic knowledge. These are skills transferrable outside of the Report Writing course and are desirable on entering the job market or graduate school.

REFERENCES

Alexander, P., and Murphy, P. 2000. The research base for APA's learner-centered psychological principles. *In* Lambert, N. and McCombs, B., eds., How students learn. Washington, DC: American Psychological Association, p. 25–60.

Association of American Colleges and Universities. 2002. Greater expectations: A new vision for learning as a nation goes to college. Available at http://www.greaterexpectations.org (accessed 18 July 2011).

Blumberg, P. 2009. Developing learner-centered teaching: A practical guide for faculty. San Francisco: Jossey-Bass, 314 p.

Bransford, J.D., Brown, A.L., and Cocking, R.R., eds. 2000. How people learn: Brain, mind, experience, and school. Washington, DC: National Academy Press, 374 p.

Gonzales, D., and Semken, S. 2009. A comparative study of field-inquiry in an undergraduate petrology course. *In* Whitmeyer, S.J., Mogk, D.W., and Pyle, E.J., eds., Field geology education: Historical perspectives and modern approaches: Geological Society of America Special Paper 461. Boulder, CO: Geological Society of America, p. 205–221.

Heffernan, K.P., Heywood, N.C., and Ritter, M.E. 2002. Integrating field trips and classroom learning into a capstone undergraduate research experience. *Journal of Geography*, 101:183–190.

Hemler, D., and Repine, T. 2006. Teachers doing science: An authentic geology research experience for teachers. *Journal of Geoscience Education*, 54:93–102.

Jarrett, O.S., and Burnley, P. 2010. Lessons on the role of fun/playfulness from a geology undergraduate summer research program. *Journal of Geoscience Education*, 58:110–120.

Kent, M., Gilbertson, D.D., and Hunt, C.O. 1997. Fieldwork in geography teaching: A critical review of the literature and approaches. *Journal of Geography in Higher Education*, 21:313–332.

Marvell, A. 2008. Student-led presentations in situ: The challenges to presenting on the edge of a volcano. *Journal of Geography in Higher Education*, 32:321–335.

National Science Foundation. 1996. Shaping the future: New expectations for undergraduate education in science, mathematics, engineering, and technology. Available at http://www.nsf.gov/pubs/stis1996/nsf96139/nxf96139.txt (accessed 18 July 2011).

University of Pittsburgh. 2009. University of Pittsburgh fact book. http://www.ir.pitt.edu/factbook/documents/fb09_016.pdf (accessed 6 March 2012).

Weimer, M. 2002. Learner-centered teaching: Five key changes to practice. San Francisco: Jossey-Bass, 288 p.

Whitmeyer, S.J., Mogk, D.W., and Pyle, E.J., editors. 2009. Field geology education: Historical perspectives and modern approaches. Geological Society of America Special Paper 461. Boulder, CO: Geological Society of America, 356 p.