Place in the City: Place-Based Learning in a Large Urban Undergraduate Geoscience Program

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ABSTRACT

One of my principal goals at the University of Minnesota is to transform the university's entry-level geoscience program into an effective "concluding" geoscience course that provides students with a clear understanding of the many interactions between Earth processes and human society. Although place-based learning appeared to be a promising way to achieve that goal, I was initially concerned whether the urban character of the university's campus and student body, the program's size, and its rapidly overturning instructional staff might limit its effectiveness. To test its effectiveness in such an educational setting, I incorporated elements of place-based learning into a multiyear renovation of the university's Earth Sciences 1001 (ESCI 1001) laboratory program. Over half of the laboratory exercises are now place-based learning that explore historical interactions of Earth processes and Upper Midwest society. Since the initiative's goals differ from those of traditional introductory geoscience courses, assessment relied on student course evaluations and student perceptions of the place-based materials. After renovation, the place-based ESCI 1001 program was the most highly evaluated entry-level science laboratory program at the University of Minnesota. This confirmed that place-based learning can be a remarkably effective pedagogical approach to undergraduate geoscience education, even in large programs with predominantly urban student populations.
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Key words: place-based, urban, geoscience education, concluding geoscience course

INTRODUCTION

All too often, the term "introductory geoscience course" turns out to be a misnomer. Although such classes are typically taught as introductions to the geoscience field, students taking the classes seldom have any intention of continuing in geoscience and often do not even intend to take another science course. The majority of students enrolled in these classes would be better served if their course was specifically designed to be a "concluding geoscience course": a course that did not prepare them for a career in Earth Science but instead provided them with the skills, knowledge, and perspectives they need to become more informed citizens of a global community intimately intertwined with Earth processes. Although there are a variety of ways to create effective concluding geoscience courses, place-based learning is an excellent framework in which students can rediscover and redefine their relationship with the Earth. The experience at the University of Minnesota suggests that place-based learning can be a remarkably powerful pedagogical approach, even among urban students who are less innately connected to natural landscapes or Earth processes than students living in rural areas.

PLACE-BASED LEARNING

While the terminology of place-based education is relatively recent, the idea has a long history, with roots extending back past Leopold's *Sand County Almanac* (Knapp, 2005), through Dewey's *The School and Society* (Woodhouse and Knapp, 2000; Smith, 2002), to Thoreau's *Walden; or Life in the Woods* (Gruenewald, 2003b). Globally, place-based education is often associated with ecological sustainability efforts or the integration of indigenous knowledge (Glasson et al., 2010, 2006; Schroder, 2006). Nationally, K–12 place-based education is commonly associated with environmental studies or ecological sustainability (Gruenewald, 2003a; Loveland, 2003; Davidson-Hunt and O'Flaherty, 2007; Wells and Zeece, 2007) but is also effective in art, literature, or other humanities (Bishop, 2004; Ball and Lai, 2006).

Within the realm of undergraduate geosciences programs, place-based learning is arguably best known among smaller colleges serving Native American populations in rural settings, where students' historically strong ties to the land make it particularly effective (Loveland, 2003; Semken, 2005). However, place-based learning can provide similar benefits to students in urban settings regardless of ethnicity (Davies, 2006) and helps build ties to places among populations that are less intrinsically tied to the land (Semken and Butler Freeman, 2008; Semken et al., 2009).

As with any relatively new pedagogical approach, there are different definitions of place-based learning. The university's place-based efforts combined Woodhouse and Knapp's (2000) recognition that place-based learning is inherently multidisciplinary and experiential, with the five characteristics of place-based geosciences teaching suggested by Semken (2005):

- Its content focuses explicitly on the geologic and other natural attributes of a place.

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- It integrates, or at least acknowledges, the diverse meanings that place holds for the instructor, the students, and the community.
- It teaches by authentic experiences in that place or in an environment that strongly evokes that place.
- It promotes and supports ecologically and culturally sustainable living in that place.
- It enriches the sense of place for students and instructor.

This description and the university's program differ from other definitions of place-based learning that emphasize extensive outdoors experience or a commitment to community service or outreach (Smith, 2002; Sobel, 2004). The University of Minnesota lacks safe accessible local exposures for students to visit, and the program's large size precludes the possibility of long-distance field trips. Although the program recently added self-guided explorations of the campus area and Saint Anthony Falls, and intends to branch into biking or canoeing explorations of the Mississippi National River and Recreation Area and other regional parks, its place-based learning has to primarily occur within the classroom. Hence, the program's place-based nature lies in its content and theme rather than in its setting, a precedent set by Hamilton College's "The Geology and Development of Modern Africa," one of the earliest, seminal place-based courses in undergraduate geosciences education (Tewksbury, 1995).

Regardless of setting, the discipline's deep reliance on field experiences and data makes it a natural fit for place-based learning. However, this same familiarity with field experiences can inadvertently allow instructors to overlook crucial aspects of place-based learning. While geoscience educators are accustomed to the idea of using field areas in education, place-based education should go beyond the use of local examples to examine the value or meanings that societies or cultures invest in those areas. This recognizes a fundamental difference between "space" and "place." While space-based geoscience learning utilizes an area's physical geology, place-based geoscience learning builds on people's perspectives of that geology, their interactions with it, and their responses to it. While many place-based efforts emphasize Native American traditions, this social component could as easily involve disparate views of miners, farmers, and ranchers toward water resource use or the many competing perspectives of communities, industries, and landowners concerning dam construction. At the University of Minnesota, the place-based geoscience curriculum emphasizes how cultural perspectives of place evolved over time and how their evolution affected subsequent resource use or contributed to potential cultural conflict. Integrating a place's social and cultural identifications with its geology not only makes place-based curricular materials more engaging and accessible but provides another intrinsic benefit: While the use of local geology can illustrate how Earth processes work, explicitly integrating local geology with its historical and cultural impacts more effectively illustrates why Earth processes are important. This distinction is particularly relevant to entry-level concluding geosciences courses that seek to help students explore and comprehend Earth processes that will greatly affect their and their children's lives.

ESCI 1001 PROGRAM

The Earth Sciences 1001 (ESCI 1001) program[1] averaged a combined annual enrollment of 985 students for the past 5 y, divided into four lecture sections offered in fall and three lecture sections in spring. The primary target of the place-based revision was the laboratory program, which typically consists of 24–30 lab sections during the fall semester and 22–26 lab sections during the spring semester. Lab sections meet once weekly for 2 h, and students from any lecture section can enroll in any lab section. While this flexibility facilitates students' scheduling, it also disengages laboratory and lecture components, because lecture sections do not share a common syllabus. Consequently, when the laboratory program was revised, one of the revision goals was to have the laboratory program act as a stand-alone exploration of geoscience that was augmented by, but not dependent upon, the course's lecture component. On average, there are 12 lab instructors each semester, half of whom are undergraduate lab instructors. Each lab section consists of 20 students, so depending on their appointment level, individual lab instructors are responsible for 40–80 students, a significant load for relatively inexperienced instructors.

Moreover, these inexperienced instructors are working with students who have few connections to the geoscience discipline and are often quite science phobic. Remarkably few of the Earth Science program's students are considering a major in Earth Sciences. Typically, less than 1% of the class admits to any professional interest in the field on entering the class, and over 80% of the ESCI 1001 students have no intention of ever taking another physical science course. Hence, teaching the class as an introduction to the field, or as initial preparation for geoscience majors, creates a serious disconnect from most students' needs or interests. In light of this, I received a 2003 Fund to Improve Postsecondary Education (FIPSE) grant from the Department of Education to revise the ESCI 1001 laboratory program into a concluding Earth Science course. Paradoxically, although not necessarily surprisingly, once instructors began to teach the class as a concluding geoscience course, rather than for major preparation, the number of students in the class who decided to become majors more than doubled.

CONCERNS OVER A PLACE-BASED APPROACH

My initial interest in place-based learning was sparked by a brief poster session discussion with Steve Semken (who at that time taught at Diné College, Navajo Nation). Although place-based learning intuitively seemed like it would work well as a concluding geoscience course design, I was concerned whether it would work as effectively on the University of Minnesota's campus as it had with Semken's students, who came from rural settings and whose families had strong ties to the land. In contrast, the university's program is dominated by urban students whose connection to nature and place is often tenuous. Of 886 students surveyed in ESCI 1001 laboratory classes, 78% came from Minnesota or an adjacent Upper Midwest state (with

[1]During summer 2011, the department changed names from the Department of Geology and Geophysics to the Department of Earth Sciences. Consequently, during its laboratory revision, ESCI 1001 was known as Geology 1001.

TABLE I: Survey statements concerning Earth processes and Earth Science courses.

Statement No.	Statement Text
1	The distribution and availability of natural resources have had a major impact on human history.
2	Some of the greatest challenges our present society faces will involve Earth processes and resources.
3	It would be better if our politicians understood more about Earth processes and how they affect society.
4	Earth processes may influence our global society but are unlikely to directly affect my life or my family.
5	Apart from the distribution of natural resources or the occasional natural disaster, Earth processes occur on such a slow time frame that they have had little impact on human history.
6	Although Earth processes may eventually pose a challenge for human society, those challenges are unlikely to occur in my lifetime.
7	The Earth Sciences appear to consist of disconnected topics that do not relate to one another.
8	The Earth Sciences seem to be some of the more difficult sciences to understand.
9	As a subject, the Earth Sciences do not really relate to my life.

Minnesota accounting for 62%), while the remaining 22% were evenly composed of students from other states and international students (with China, Korea, and Japan each contributing significant segments). Nearly 81% of the surveyed domestic students come from urban settings, while only 4% come from rural areas and 15% come from small towns. The international students are even more urban, with 93% coming from large metropolitan centers. Overall, this population is quite dissimilar from the audiences of many place-based programs.

Traditionally, place-based education has flourished within smaller programs, rural settings, and/or with populations that historically had strong connections with the Earth. Urban students tend to have fewer connections to Earth processes and—at least in the Upper Midwest, where outcrops and Earth Science professions are both relatively scant—fewer personal ties to Earth Science. Students entering the ESCI 1001 program were asked to rate their level of agreement to six statements concerning the importance of Earth processes in their lives and to human society and two statements concerning Earth Science (Table I). Some statements portrayed Earth processes and Earth Science as being relevant, while others downplayed their significance. Positive and negative views were randomly mixed in the actual survey but were separated later for comparison. The left side of Figure 1 shows students' level of agreement with statements that suggest Earth processes are important, while right side shows students' level of disagreement with statements that suggest Earth processes are not important or that disparage Earth Science. Survey responses reveal subtle differences between the perceptions of students who came from urban backgrounds and those who claim a more rural background, with rural students consistently viewing Earth processes and Earth Science more favorably than urban students. As over 80% of our students come from urban settings, I was concerned that this difference might limit the effectiveness of place-based learning.

Other concerns centered on the size of the program and the background of the laboratory instructors. Again, place-based learning has traditionally been most successful in programs of modest size and with permanent, often very experienced, instructors. With an annual enrollment of over 1,000 students, the size of the program placed logistical limits on what activities could be undertaken. More importantly, place-based learning had to focus on the laboratory component of the program, which is taught by graduate and undergraduate instructors with limited teaching experience, the difficulties being further compounded by high teaching loads of up to 80 students per lab instructor and high turnover rates (the average instructor only teaches in the program for two semesters). While they do an outstanding job of teaching, over half of the program's instructors are undergraduate students, who are often only a semester or two beyond being in ESCI 1001 as a student. While many place-based learning initiatives make use of student journals, self-reflections, and observations, successfully managing those approaches can challenge experienced instructors working with small classes, much less novice teachers. Consequently, the program had to adopt a slimmed-down variety of place-based learning that lacks the corroborating activities common to smaller programs with experienced instructors. At the time, it was unclear whether this lack would limit the pedagogical efficacy of place-based geoscience education. As it turned out, these fears were unfounded.

ESCI 1001 PLACE-BASED LEARNING COMPONENTS

Although nearly the entire laboratory program includes place-based materials, not all modules are place based to the same extent. Through the first half of the revised ESCI 1001 laboratory program, examples of how river, igneous, sedimentary, and metamorphic processes have impacted Upper Midwest history are woven into the laboratory modules. Many of the threads explored in these earlier labs are then revisited in the second half of the laboratory program, which consists entirely of place-based explorations that place as much emphasis on the social implications of Earth processes as on understanding the processes. Within the past year, self-guided explorations of the campus area and Saint Anthony Falls (located a mile from campus) allow students to investigate the evolution of the campus landscape and a waterfall's impacts on human history, along with differing cultural perspectives of those falls over time. In light of the region's cultural heritage, most of the program's place-based materials' cultural exploration begins with 18th-century Dakota, Ojibwe, and Euro-American perspectives and follows the evolution of these cultural perspectives from

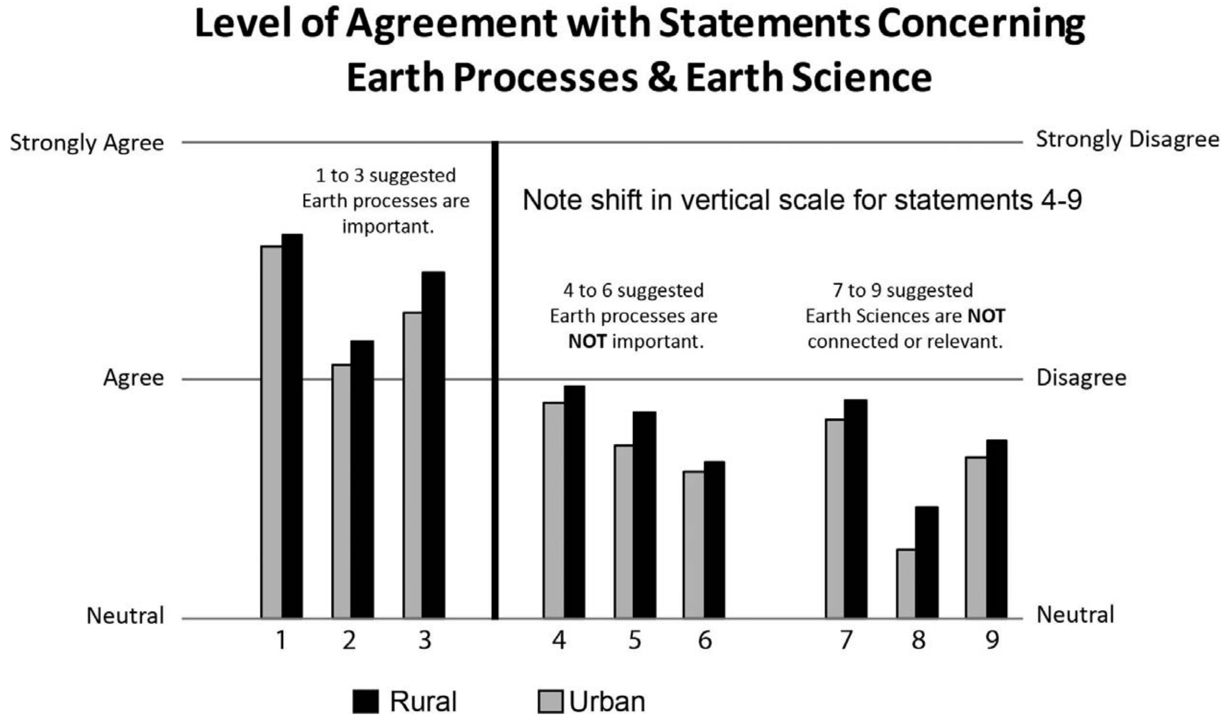

FIGURE 1: Average levels of agreement to nine statements about Earth processes and Earth Science reported by 312 students from urban backgrounds and 75 students from rural backgrounds in ESCI 1001. The nine statements are listed in Table I.

the 18th century to the present. The goals are to help students understand how cultures use and view their world in different ways, consider how geologic processes have affected human history, and realize that every use of the Earth involves benefits, costs, and risks.

Although most place-based learning promotes ecologically and culturally sustainable living, the goal is to accomplish that by improving students' ability to comprehend how differing cultural perspectives evolved over time and to comprehend the economic, ecological, and societal impacts of those evolving perspectives. This historical approach is an alternative to the explicit advocacy of many place-based learning initiatives (Fawcett et al., 2002; Nespor, 2008). The educators in the program felt a historical approach enables students to critically consider the complexity of competing viewpoints without triggering the deeply held partisan feelings associated with many contemporary environmental issues. An interesting counterpoint to this historical approach is provided by Semken and Brandt's (2010) use of place-based learning to directly explore contemporary social conflicts in the southwestern U.S. and Malaysia.

Place-Based Laboratory Modules

Although elements of place-based learning are woven into all but one of the laboratory modules, four are wholly place-based explorations that adopt a historical approach to place-based geoscience education.

"The Upper Midwest's Glacial Legacy" explores the many impacts glacial systems had on the present landscape, ecosystems, and human history. While this lab introduces a broad overview of the Upper Midwest region, it focuses primarily on two glacial legacies: the pine forests that stretched across much of Minnesota in the late 1800s and the rich glacial soils of the Minnesota River Valley. Students explore how 18th- and 19th-century Ojibwe, Dakota, and Euro-American societies' use of these resources differed from one another and how these uses evolved over time, as woodlands and prairie became "timber" and "acreage." Eventually these differences in cultural perspective and resource use became mutually exclusive and inevitably contributed to past and present cultural conflicts.

"A River Through Time: 'Managing' the Upper Mississippi River" explores river processes by following historic efforts of the Army Corps of Engineers to manipulate those processes to force the Mississippi River to erode a deeper, more continuous channel for commerce. Combining physical stream table models with historic maps and photographs, students compare the efficacy and consequences of earlier wing dam and riprap management of the river with subsequent lock and dam management. Along the way, students explore how efforts to improve the river for navigation affected wetland habitat and associated ecological systems, as well as current efforts to balance these competing concerns.

"In the Wake of a Waterfall: The Geology Behind the Founding of Minneapolis & St. Paul" combines rock samples with physical models of waterfall evolution and radiocarbon dating to explore the geology behind Saint Anthony Falls' origin and subsequent evolution. The lab guides students through the origin, testing, and revision of historic scientific hypotheses on the timing of the waterfall's retreat as new data and techniques emerged over a century of study. In addition, it explores the intertwined impacts of the waterfall on human history and human actions on the waterfall system in a wide-ranging exploration that moves from early

Dakota spiritual beliefs, through logging and milling operations, to the area's current rebirth as an urban recreational area.

"Still Waters, Silent Witnesses: Interpreting Lake Sediment Records" is built about physical samples and digital images of lake sediment cores from a Twin Cities metropolitan lake. Students explore how lake sedimentation responded to changes in the lake's drainage basin as the area changed from prairie and woodlands through early agricultural efforts to become a fully urban lake. Creation of a recreational beach, housing divisions, urban sewage, and the use of salt on winter roads all left identifiable changes in the lake's sedimentary record, as did recent remediation efforts to restore the lake's ecosystem, such as establishment of a sanitary sewer system, wetlands restoration, sediment catchment basins, and alum treatment.

Self-Guided, Place-Based Field Explorations

When I first came to Minnesota, I had the dubious honor and unforgettable experience of leading 300 students on a field trip through the St. Croix River Valley. A rite of passage for new instructors, it was a memorable introduction to the logistical nightmare of attempting to integrate meaningful field experiences into large enrollment programs. It took me years to come up with a successful solution. I finally realized that instead of leading large field trips or having lab instructors lead multiple smaller field parties, the program had to empower students to lead their own field experiences. Consequently, I created two self-guided, place-based explorations that provide background content, navigation directions, and a set of observation-based questions that allow students to explore field settings on their own or with friends and family. This initiative, built on a previous effort to create self-guided student explorations of museum exhibits (Kirkby and Phipps, 2011), expands the concept to place-based field experiences that give students responsibility and control of their own learning.

"Geology of the Historic Campus Area" provides students with a different perspective on the campus they stroll through daily. This exploration alternates between examining the information encoded within building stones on the region's geologic history and exploring the processes that created the present campus landscape, along with the impact of those processes on society. Consequently, the exploration ranges from how campus building stones reflect the collision of microcontinents that built North America or recall long-vanished epeiric seas through glacial and fluvial shaping of the campus terrain to how that landscape altered the path of Red River oxcart trains and directly led to the founding of two major cities.

"A Geologic Tour of Saint Anthony Falls" is a self-guided walking or biking tour of the Saint Anthony Falls area that allows students to explore the geology behind the waterfalls' evolution, its early interpretation and exploitation by 18th- and 19th-century Dakota and Euro-America societies, and its subsequent social and economic impacts on Upper Midwest societies. Unlike traditional geology fieldtrips, this self-guided exploration focuses on the impacts of geologic processes on human society and how the use of geologic resources has evolved over time. A wide-ranging exercise that interweaves stream evolution with industrial, this exploration follows the area's transformation from a place of spiritual power to one of industrial strength, examining the path through urban decay to a city's rediscovery of the river's natural beauty.

Consequently, by the end of the ESCI 1001 laboratory revision, the program included a suite of place-based modules that took a historical approach toward students' exploration of their ties to the land, including innovative ways to have them explore and rediscover that landscape on their own, without forced guidance from instructors.

ASSESSMENT OF PLACE-BASED MATERIALS

Rigorously evaluating student learning is challenging under most circumstances, but the use of place-based instruction compounds the difficulty, since the content of traditional and place-based curricula differ greatly. Concepts and topics that underlie place-based instruction are seldom covered by more traditional laboratory instruction, which complicates the quantitative assessment of individual place-based lab components. Furthermore, as the goals of a concluding geoscience course differ so greatly from those of an introductory course, for the program a better analogy is comparing not apples and oranges but apples and marmots. While some compositional elements are similar, the courses are dealing with fundamentally different organisms.

Accordingly, the assessment relied on students' overall perspective of the program and its elements through the use of student evaluation of teaching (SET) responses and opinion surveys. These materials targeted assessment at three different levels within the university structure. Initially, the assessors used student surveys on the laboratory modules to guide and assess the impact of place-based materials during the lab program revision. Subsequent surveys asked students in different Earth Science courses to rate the relative efficacy of their lab and lecture components. Their purpose was to see how the place-based ESCI 1001 program compared to more traditional entry-level geoscience programs. Finally, university end-of-semester course evaluation data compared the ESCI 1001 program with other physical science laboratory programs.

Assessment Within the ESCI 1001 Program

The assessors relied on two surveys to track student response to place-based learning during the ESCI 1001 program revision. Both surveys were given to students when the program consisted of a mixture of place-based modules and traditional geoscience modules.

Prior to the laboratory program's place-based revision, students had consistently chosen the campus tour lab as its most effective laboratory exercise. As the previous laboratory program's only "field" activity, classes toured the campus with lab groups, preparing and presenting background on different campus building stones. Students enjoyed being out of the classroom and credited the campus tour lab with making them more aware of building stones on campus and other settings. Although the campus tour lab was a space-based exercise that took advantage of local "geologic" resources, it was not a place-based experience that set those resources in a context of their human value. Still, as it was the most highly evaluated laboratory activity, the university kept the campus tour lab unchanged until the end of the

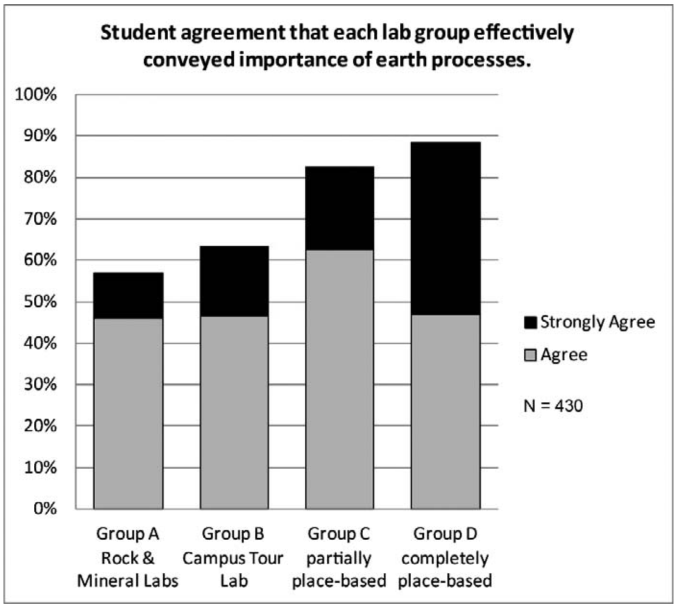

FIGURE 2: Student response to statements that each of the lab groups was effective at conveying the societal importance of geologic processes. The survey was taken when the ESCI 1001 laboratory program consisted of a mixture of its original labs (Groups A and B) and new place-based labs (Groups C and D).

program's revision so that it could be used as a benchmark comparison for the new place-based modules.

The first survey asked students to compare the effectiveness of the program's laboratory modules in conveying the societal importance of Earth processes and materials. To simplify this comparison, the 10 laboratory modules were divided into four groups:

- Group A—Unrevised, traditional mineral and rock labs
- Group B—Unrevised, student-led campus tour lab (the benchmark)
- Group C—Revised labs with some place-based components
- Group D—Revised labs that were wholly place-based laboratory modules

For each of the groups, students were asked to what extent they agreed or disagreed with the statement "I thought that the content of labs in Group X was effective in conveying the importance of geology and geologic processes to our society." Reponses used a 5-point Likert scale of "strongly disagree," "disagree," "neutral," "agree," and "strongly agree." Responses confirmed anecdotal evidence reported by laboratory instructors that the revised labs had surpassed the campus tour benchmark (Fig. 2). Although the revised labs with some place-based components scored higher than the campus tour lab, students reserved their highest ratings for the wholly place-based laboratory modules. Following this survey, the unrevised, traditional mineral and rock labs were replaced by revised mineral and rock labs that relied heavily on local place-based elements and that explicitly set sample study in a context of how past and present societies used geologic resources. On subsequent surveys, these revised labs, despite students' common antipathy toward sample study, also ended up scoring higher than the unrevised campus tour lab.

A second student survey told the students that the department was creating another new laboratory module and asked them to suggest (1) which style the lab should follow and (2) which of the current labs in the program should be dropped to make space for the new lab. When asked to choose the style a new lab should follow, 54% of the students surveyed thought it should be a wholly place-based lab, while another 18% opted for a partially place based ($N = 1,157$). When asked which of the current labs should be dropped from the program to make room for a new lab, only 7% chose one of the wholly place-based labs ($N = 1,008$). Toward the end of the laboratory program revision, after student ratings of all revised laboratory modules exceeded the unrevised campus tour lab, the university followed their suggestions and retired the campus tour lab to replace it with a wholly place-based laboratory on local lake sediment records. At that point, student evaluations for all of the new place-based laboratory program components exceeded those of the original laboratory program's most highly evaluated laboratory exercise.

Assessment Within University of Minnesota's Geoscience Program

Later, to compare the revised place-based ESCI 1001 laboratory program with other entry-level geoscience programs taught by comparable staff, students in all of the university's entry-level geoscience laboratory courses were asked to independently rate the effectiveness of their courses' lab and lecture components in providing a better understanding of the many interactions between Earth processes and human society. These surveys used a 7-point Likert scale, with 1 being "not at all successful" and 7 being "extremely successful." On these surveys, students consistently rated the ESCI 1001 place-based revised laboratory program as being more effective than the laboratory programs in comparable entry-level Earth Science courses (Table II), including an innovative course that used cinema to teach geoscience.

Although the average scores of Table II suggest the place-based laboratory renovation was successful, the differences between how students ranked the course's lab and lecture components can be even more instructive. Higher average scores could simply reflect that students preferred one class more than another rather than that its laboratory program was more effective. Consequently, the assessment also compared whether individual students rated their course's laboratory component as being more effective than, as effective as, or less effective than the lecture component—regardless of how far apart those differences were. Students who rated their lab component at 7 and their lecture at 1 fell in the same category as those who rated their lab at 5 and lecture at 4. Students in the place-based ESCI 1001 program overwhelmingly rated their laboratory component as being far more effective than traditional lecture instruction (Fig. 3). In every traditional lecture section surveyed, 50%–74% of the students rated the laboratory component as being more effective than the lecture component (and 84%–92% rated the laboratory component to be as effective as or more effective than the lecture component). Overall, less than

TABLE II: Effectiveness in conveying a better understanding of Earth processes.

ESCI 1001 Place-Based Lab Program	*N*	Average Score[1]	Other Earth Science Non–Place-Based Lab Programs	*N*	Average Score[1]
Spring 2008	152	5.5	Control class 1	51	3.8
Spring 2007	196	5.7	Control class 2	205	4.7
Spring 2006	128	5.6	Control class 3	73	4.8
Average	476	5.6	Average	329	4.4

[1]On 7-point Likert scale, from 1 (not at all successful) to 7 (extremely successful).

13% of the 1,195 students surveyed in 10 lecture sections rated their lecture as the more effective educational component. By comparison, 35%–52% of the students in two entry-level geosciences courses with non–place-based laboratory programs thought their lecture component was the more effective component (Fig. 3). Although both comparison courses included innovative labs specifically designed to engage students, such as computer-based oceanography labs or movie-themed physical geology labs, the stark difference in student rankings suggests that the ESCI 1001 place-based labs were more effective.

As all of the lecture sections above were taught by different instructors, to remove any impacts the lecture instructor may have on student rankings of course components, surveys were also given to five classes I taught. Three of these classes were ESCI 1001 lecture sections associated with the place-based ESCI 1001 laboratory program. The other two courses had innovative laboratory programs that did not use a place-based theme. In contrast to the previous comparison, none of these lecture sections were taught in a traditional lecture style. Although the three courses covered different topics, I taught all five lecture sections using similar lecture methods, including innovative active learning activities, robust visualization components, and targeted interventions that were designed to correct student misconceptions. Each of the five lecture sections was the highest-evaluated large-enrollment, entry-level lecture course taught at the University of Minnesota during its respective semester, so there was little difference in students' perspective of their lecture component. By default, the laboratory programs ended up being the determining factors in students' relative rankings of course components. Despite very high lecture course evaluations, a majority of students in each of the three ESCI 1001 sections still rated the revised place-based laboratory component as being as effective as or more effective than the lecture (Fig. 4). In contrast, over 76% of the students in the two classes using non–place-based labs instead rated their lecture experience as the most effective course component (compared to only 35%–45% of students in the ESCI 1001 sections). Only 2%–6% of students in the non–place-based laboratory programs rated the labs as being more effective than the lectures, compared to 15%–27% of students in the ESCI 1001 sections. This assessment confirmed that students thought the ESCI 1001 place-based laboratory program was more effective than the other entry-level geoscience laboratory programs.

Assessment Across University of Minnesota's Physical Science Programs

The university's end-of-semester student course evaluations provided a way to compare the place-based ESCI 1001 laboratory program with comparable physical science laboratory programs. Three other entry-level physical science programs were matched against the ESCI 1001 program: physics, astronomy, and the Department of Earth Sciences's non–place-based geoscience laboratory programs. By the time of the comparison, the university's entry-level chemistry program had switched to another evaluation form, but in previous years its evaluation efforts closely matched those of the three comparison programs. All four of the laboratory programs consist of service courses that serve a diverse student population, but three are primarily liberal education breadth requirement courses, while the physics program also includes courses required for a number of majors. Consequently, the ESCI 1001, astronomy, and non–place-based Earth Science programs have remarkably similar audiences. In all three programs, two-thirds of the students are in their first or second year. Two-thirds of the program's students come from the College of Liberal Arts, while less than 5% of them are enrolled in the College of Science and Engineering. Even fewer students (less than 1%) are from the College of Biological Sciences. In contrast, the physics program includes a significant number of science and engineering students among its target population. However, as it is not immediately obvious why having a larger proportion of non–science-phobic students with interests in the discipline should be disadvantageous to a program's evaluation ratings, they are included here as another, albeit slightly different, comparison.

By the end of the ESCI 1001 laboratory program's renovation, student evaluations consistently placed it as the highest-evaluated physical science laboratory program at the University of Minnesota (Table III). This ranking was based on how students rated their lab instructor's overall teaching ability and on how much they thought they learned in the course. Although the first question, "How would you rate the instructor's overall teaching ability?" targeted lab instructors, the department had previously established a strong correlation between students' evaluation of their lab instructor and the laboratory program design. Students rated individual instructors an average of 0.5 points higher (on a 7-point scale) when they taught in the ESCI 1001 program compared to their scores in any of the department's other entry-level geoscience programs. Similarly, at the end of the program revision, the place-based ESCI 1001 laboratory sections' average of 6.2 (on a 7-point scale) was 0.4 points higher than the 5.8 average earned by other non–place-based, entry-level geosciences programs and 0.4 to 0.7 points higher than the averages for the university's other physical science laboratory programs.[2] For programs with enrollments from

[2]After spring 2007, the university changed its course evaluation form, so that was the last semester when comparable data was available to assess prerevision and postrevision versions of the courses.

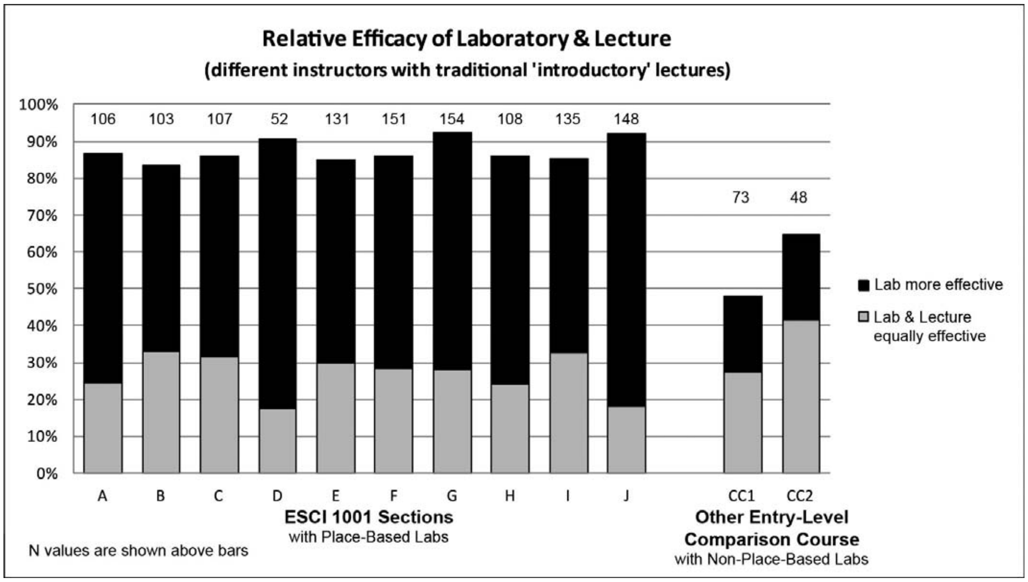

FIGURE 3: Student rating of the relative effectiveness of their courses' lab and lecture components in 10 sections of ESCI 1001 with place-based labs and in 2 entry-level geoscience courses without place-based labs that were all taught by different instructors.

234 to 1,337 students, gains of 0.4 to 0.7 on a 7-point Likert scale represent substantial differences in program averages.

A second question on the university's SET form attempted to gauge how much students learned in the course. Unfortunately, one of the university's responses for the question "How much would you say you learned in this course?" was poorly worded. The midrange response (4) for this item was listed as "amount expected," which meant that if students expected to learn a lot from the class and did, they could conceivably chose 4 on the 7-point Likert scale rather than 6 or 7. Consequently, average SET scores on this question are always lower than for the previous question on instructors' overall teaching ability. Still, in spring 2007, the ESCI 1001 place-based laboratory program averaged 5.5 on this question, which was substantially higher than the 5.2 average earned by other non–place-based Earth Science lab sections or the average scores of 4.9 for the university's other physical science laboratory programs.

Finally, unsolicited student comments on the laboratory program attest to the place-based revision's efficacy and appeal. Before the place-based revision of the ESCI 1001 lab program, typically 15% of students mentioned unflattering

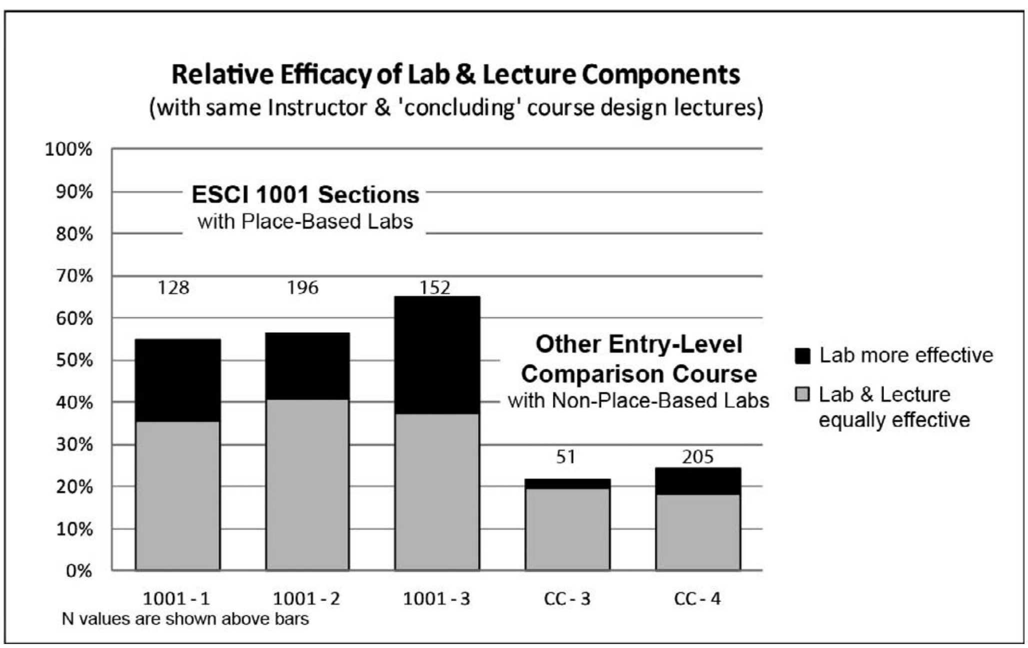

FIGURE 4: Student rating of the relative effectiveness of their courses' lab and lecture components from five of my lecture sections, including three ESCI 1001 sections with place-based labs and two entry-level geoscience courses without place-based labs.

TABLE III: Student evaluations of physical science laboratory programs.

Spring 2007 Physical Science Labs		"How would you rate the instructor's overall teaching ability?"		"How much would you say you learned in this course?"	
Program	No. Lab Sections	Score Range[1]	Average Score[1]	Score Range[1]	Average Score[1]
Astronomy	$N = 25$ labs (413 students)	4.7–6.8	5.8	4.0–5.8	4.9
Physics[2]	$N = 135$ labs (1,337 students)	3.0–7.0	5.5	3.1–6.6	4.9
Earth Sciences (non–place based)	$N = 16$ labs (234 students)	4.7–6.6	5.8	4.4–5.8	5.2
ESCI 1001 (place based)	$N = 25$ labs (521 students)	5.7–6.8	6.2	4.6–6.0	5.5

[1]On a 7-point Likert scale.
[2]In contrast to the other programs, physics included significant numbers of students who are taking the course to fulfill their major requirements rather than their liberal education requirements.

comments about the labs on lecture evaluations, even though the lab and lecture components were evaluated separately. After the laboratory program's revision, disparaging comments about the laboratory program disappeared from lecture evaluations. More importantly, and more unexpectedly, I began to receive unsolicited e-mails from students in other lecture sections mentioning how much they enjoyed the lab activities. These students had asked their lab instructors about the program and who was responsible for it and then taken the time and made the effort to contact me with their thanks. In my experience, this was the first time that a lab revision not only garnered this level of unsolicited compliments but even resulted in parents of students asking for copies of laboratory materials for use in high school classes and with youth groups.

In summary, student opinion surveys within the ESCI 1001 program consistently rated the place-based laboratory components as being more effective than the older non–place-based modules, while comparison of student surveys in ESCI 1001 and other programs similarly rated the place-based ESCI 1001 laboratory program as being more effective than comparable entry-level physical science programs.

CONCLUSIONS

> *"Places matter. Their rules, their scale, their design include or exclude civil society, pedestrianism, equality, diversity (economic and otherwise), understanding of where water comes from and garbage goes, consumption or conservation. They map our lives."*
>
> *—Rebecca Solnit, Storming the Gates of Paradise: Landscapes for Politics*

Paradoxically, globalization has increased the relevance of local place-based learning, rather than diminished it (Gruenewald, 2003b; Stevenson, 2008). While understanding global connections between Earth processes and society have become increasingly important, those linkages are more easily created on a local scale, where place-based learning builds on students' prior knowledge and experiences to create a more robust understanding of the entwined relationship between human societies and Earth processes. This facilitates not only students' comprehension of how Earth processes work but also students' appreciation of their importance. Consequently, place-based learning is a particularly powerful pedagogical approach in entry-level programs specifically designed to be concluding geosciences courses built about the interactions of Earth processes and human activities.

While many place-based initiatives focus on rural student populations with strong connections to place, the experience at the University of Minnesota supports Semken and Butler Freeman's (2008) belief that place-based learning can be equally effective within urban student populations, where students are not as intrinsically linked to the land. Despite the highly urban character of the campus and student body, place-based geoscience education has proven to be remarkably successful, even in classes taught by relatively inexperienced student instructors. Distinctive characteristics of place-based learning include its emphasis on the evolution of cultural perspectives of place over time and the use of self-guided, place-based field experiences to provide students control over their exploration of a place's myriad meanings. By interweaving local geology with past differing cultural perspectives and historical impacts, the place-based materials underscore the complex interactions between Earth processes and human society without necessarily triggering the strong partisan reactions often associated with contemporary Earth system concerns. Establishing past social and cultural connections to local places also provides intellectual scaffolding for students to better understand present global connections between Earth processes and society.

By creating connections between geology and society, place-based learning not only alters physical spaces into places imbued with meaning but can transform a geoscience program to be more accessible and engaging. Despite their dominantly urban background and initial disengagement from Earth processes, by the course's end, students at the University of Minnesota consistently rank the place-based ESCI 1001 laboratory program as the university's most effective physical science laboratory program. Within the program, students attribute its success to its place-based curricular elements, proving that a pedagogical approach pioneered with rural student populations can resonate as strongly with urban students. With its focus on the myriad interactions of geology and society, place-based learning is a particularly powerful pedagogical approach for concluding geoscience courses that seek to convey the many essential roles Earth processes play in the present world.

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REFERENCES

Ball, E.L., and Lai, A. 2006. Place-based pedagogy for the arts and humanities. *Pedagogy,* 6(2):261–287.

Bishop, S. 2004. The power of place. *English Journal,* 93(6):65–69.

Davidson-Hunt, I.J., and O'Flaherty, R.M. 2007. Researchers, indigenous peoples, and place-based learning communities. *Society Natural Resources,* 20(4):291–305.

Davies, C.P. 2006. Implementing Earth systems science curriculum: Evaluating the integration of urban environments for an urban audience. *Journal of Geoscience Education,* 54(3):364–373.

Fawcett, L., Bell, A.C., and Russell, C.L. (2002). Guiding our environmental praxis: Teaching for social and environmental justice. *In* Leal Filho, W., ed., Teaching sustainability at universities: Towards curriculum greening. New York: Peter Lang Scientific Publishers, p. 223–228.

Glasson, G.E., Frykholm, J.A., Mhango, N.A., and Phiri, A.D. 2006. Understanding the Earth systems of Malawi: Ecological sustainability, culture, and place-based education. *Science Education,* 90(4):660–680.

Glasson, G.E., Mhango, N.A., Phiri, A.D., and Lanier, M. 2010. Sustainability science education in Africa: Negotiating indigenous ways of living with nature in the third space. *International Journal of Science Education,* 32(1):125–141.

Gruenewald, D.A. 2003a. The best of both worlds: A critical pedagogy of place. *Educational Researcher,* 32(4):3–12.

Gruenewald, D.A. 2003b. Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal,* 40(3):619–654.

Kirkby, K.C., and Phipps, M. 2011. Giving students control over their learning, from self-guided museum visits and field trips to using scanning technology to link content to Earth samples. Abstract No. ED31A-0718, American Geophysical Union, Fall Meeting 2011.

Knapp, C.E. 2005. The I–thou relationship, place-based education, and Aldo Leopold. *Journal of Experiential Education,* 27(3):277–285.

Loveland, E. 2003. Achieving academic goals through place-based learning: Students in five states show how to do it. *Rural Roots,* 4(1):6–11.

Nespor, J. 2008. Education and place: A review essay. *Educational Theory,* 58(4):475–489.

Schroder, B. 2006. Native science, intercultural education and place-conscious education: An Ecuadorian example. *Educational Studies,* 32(3):307–317.

Semken, S. 2005. Sense of place and place-based introductory geoscience teaching for American Indian and Alaska Native undergraduates. *Journal of Geoscience Education,* 53(2):149–157.

Semken, S., and Butler Freeman, C. 2008. Sense of place in the practice and assessment of place-based science teaching. *Science Education,* 92(6):1042–1057.

Semken, S., Butler Freeman, C., Watts, N.B., Neakrase, J.J., Dial, R.E., and Baker, D.R. 2009. Factors that influence sense of place as a learning outcome and assessment measure of place-based geosciences teaching. *Electronic Journal of Science Education,* 13:136–159.

Semken, S., and Brandt, E. 2010. Implications of sense of place and place-based education for ecological integrity and cultural sustainability in diverse places. *Cultural Studies of Science Education,* 3:287–302.

Smith, G.A. 2002. Place-based education: Learning to be where we are. *Phi Delta Kappan,* 83(8):584–594.

Sobel, D. 2004. Place-based education: Connecting classrooms and communities. Great Barrington, MA: The Orion Society, 109 p.

Stevenson, R.B. 2008. A critical pedagogy of place and the critical place(s) of pedagogy. *Environmental Education Research,* 14(3):353–360.

Tewksbury, B.J. 1995. Connecting the geology of Africa with the prehistoric, historical, political, and economic evolution of the continent as a strategy for teaching introductory geology and attracting minority students to geology. *Journal of Geological Education,* 43:492–496.

Wells, R., and Zeece, P.D. 2007. My place in my world: Literature for place-based environmental education. *Early Childhood Education Journal,* 35(3):285–291.

Woodhouse, J.L., and Knapp, C.E. 2000. Place-based curriculum and instruction. ERIC Document Reproduction Service, No. EDO-RC-00-6.