

Brownfield Action Online— Using Technology to Extend Access to Non-Traditional Students

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Introduction

Brownfield Action (BA) is a SENCER Model that is a web-based, interactive, three-dimensional digital space and learning simulation in which students form fictitious geotechnical consulting companies and work collectively to explore problems in environmental forensics. Created at Columbia University's Barnard College in conjunction with Columbia's Center for New Media Teaching and Learning, BA has a 12-year history of use at Barnard as a full semester activity in a two-semester Introduction to Environmental Science course. Each year more than 100 non-science majors take BA as an option to satisfy the College's undergraduate science requirement. The pedagogical methods and design of BA are grounded in a substantial research literature focused on the design, use, and effectiveness of games and simulation in education (Bower et al. 2011). The variety of ways in which the BA simulation is used at Barnard and nine other educational institutions in the United States is described in Bower et al. (2014).

Although BA is web-based, there are components that are done in the classroom to complement the online instruction. The components include making topographic, bedrock, and groundwater maps; laboratory experiments to determine the porosity and permeability of sediment; and observation of the migration of a contaminant plume in a sand tank designed for that purpose. In this report we describe how we taught BA online to non-traditional students who use the course to satisfy an elective science requirement at the City College of New York (CCNY). The CCNY learning management system (LMS) is Blackboard 9.1, but any LMS can be used when teaching BA online. The course combined mainly asynchronous instruction, in which the students accessed course material and learned it outside the classroom at their leisure, and in-class instruction evenly spaced during the semester, when all of the students were present. It was in the classroom that students did laboratory experiments with equipment that would not be available away from the College. Examples of equipment that makes the learning experience meaningful to the students are sediment

sieves for mechanical separation of regolith (sand) into different sizes or fractions, a triple-beam balance for measuring the mass of each sand fraction, a permeameter to measure the permeability coefficient needed in the calculation of the velocity of groundwater flow using D'Arcy's Law, and a sand tank commercially obtained and designed to demonstrate the migration of a contaminated plume in groundwater.

Course Design

We used the constructionist approach (Murphy et al. 2005) to teaching BA as an asynchronous online course. An advantage of teaching BA asynchronously rather than having real-time (synchronous) communication between students and us is that it allowed the students to collapse time and space, to access the classes anywhere, and to get immediate feedback between themselves and us. Furthermore, we prefer authentic learning (Donovan et al. 1999) that involves the students in an investigation of a relevant issue such as a brownfield because it applies well to someone who lives in a large metropolitan area such as New York City. We are mindful that the success of the course depends much on structuring assignments so that the students see where the tasks they do help to lead to the eventual goal of the course, which is the drafting of an Environmental Site Assessment Phase I Report. We are fortunate to have more than a decade of experience developing and teaching face-to-face the assignments used in BA. Texts for the course are Jonathan Harr's *A Civil Action* and Rachel Carson's *Silent Spring*, which are accompanied by questions that direct the reading for each class.

Course Content

For faculty who intend to teach BA online, we offer here the lessons we developed for the course at CCNY. Each class consisted of a *Lesson*, *Assignment*, *Discussion*, *Questions* for reading assignments, and *Resource*, which was a PowerPoint presentation. The answers to the reading questions were known only to us and were not shared between students online. Student performance was assessed by weekly assignments and an Environmental Site Assessment Phase I Final Report.

During the first week of the course there were two three-hour classes when the students met with us on campus to make and interpret maps that are required for BA. Four additional classes during the semester when the students were

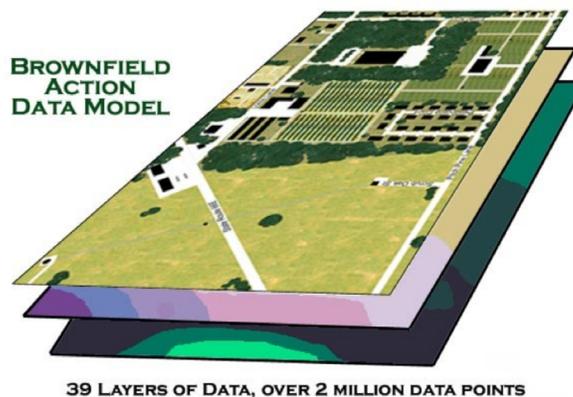


FIGURE 1. In the Brownfield Action simulation, data can be obtained for surface and bedrock topography, water table, water chemistry, soil characteristics, and vegetation as well as data from tools like soil gas, seismic reflection and refraction, metal detection and magnetometry, ground penetrating radar, and drilling.

together with us were when laboratory experiments were done to measure the porosity and permeability of regolith (sand), observe the contaminant plume in the sand tank model, and write the Environmental Site Assessment Phase I Report that was a requirement of the course. What follows is a description of the classes that can be used or adapted by other instructors when teaching BA online.

Class 1 consisted of a *Lesson* that described a brownfield and the design of the course. Because scale and a map of the region to be explored and topographic, bedrock, and water table maps are important in an environmental investigation of the kind that is done in BA, there was an explanation of the maps with all of the students present. The *Discussion* was for the students to write a paragraph telling their classmates and us something about themselves. As part of the biography, the students used the letters of their first name to describe traits they have. This activity served as an informal means of introducing the students to each other. An *Assignment* to be shared with everyone was for each student to select a park or similar site in his or her neighborhood and compute the area of that site. The intention of the assignment is to reinforce the concept of scale by comparing the area of the neighborhood site with the area of the base map (about 160 acres) and to Governor's Island in New York Harbor, which was of similar area and a familiar locality to the students. *Questions* the students saw online about Chapter 1 in *Silent Spring* and *A Civil Action* were to be answered and sent to us before the next class;

the biography using the letters of the first name was sent to everyone in the course. The *Resource* was a PowerPoint presentation about scale and the fictitious township that the students would investigate in the search for a brownfield. The class concluded with a video that described why an environmental site assessment is required for a parcel of land that a developer is considering buying; in this case, the land would be used to construct a mini-mall at the site of a former factory in Moraine Township, which is the fictitious township in the BA simulation.

The *Lesson* in Class 2 was devoted to a visual reconnaissance of Moraine Township. Because the reconnaissance is of about 160 acres, the task was divided among the students with each one assigned a sector of 20 acres. The *Assignment* required each student to report on the physical appearance of the landscape and position of buildings and roads in the sector. Students then combined the reports in the *Discussion* for use in a storyboard that would be a reference throughout the investigation. *Questions* about Chapter 2 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation that had photographs and results of the regolith sieving lab that was done in Class 1.

The *Lesson* in Class 3 was for each student to locate and describe a brownfield in his or her neighborhood, and to report it to the entire class in the *Discussion*. The *Assignment* was to summarize the information that was learned in the visual reconnaissance of Moraine Township and to identify possible sites that required examination. This information also was to be communicated to the entire class in the *Discussion*. *Questions* about Chapter 3 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation that had photographs of an abandoned gas station in Manhattan that is a brownfield. The photographs gave the students an example of what might be a brownfield in their neighborhood.

Interviews with residents in Moraine Township have the potential to provide information that will be valuable in the search for a brownfield. Those interviews are possible in the BA simulation, and the *Lesson* in Class 4 was to have each student make several interviews from 20 possible ones. The *Assignment* was for each student to report the results of the

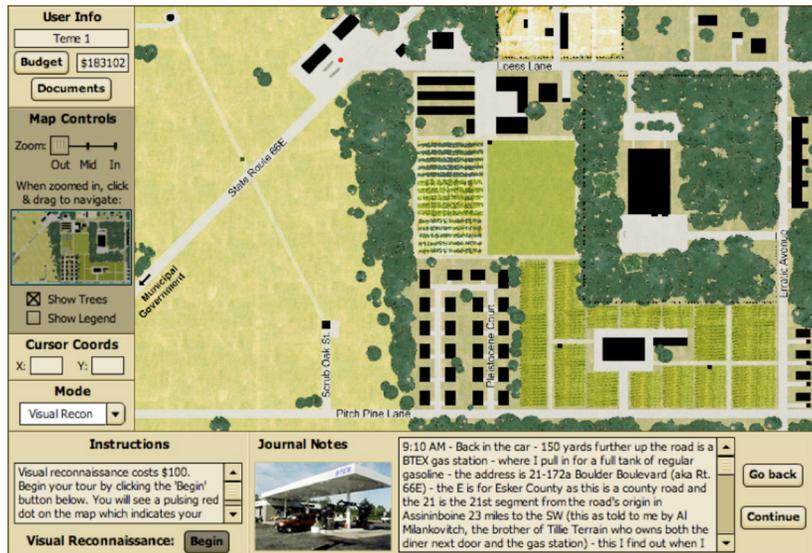


FIGURE 2. The buildings and vegetation map, which covers the “field of play” in the Brownfield Action simulation, in the Visual Reconnaissance mode that provides information about the BTEX station.

interviews in the *Discussion* that was shared with everyone, and to add the responses to the storyboard for the investigation. *Questions* about Chapter 4 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation containing information about how to conduct an interview in the BA simulation.

The students met with us in the classroom for Class 5. The *Lesson* was to introduce a plume (dye) into a sand tank designed to show how a contaminant moves from a point source in a well to a region of reduced confining pressure (pond). The *Assignment* was to calculate the rate of the groundwater flow using D’Arcy’s Law and to share the result in the *Discussion*. *Questions* about Chapter 5 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation that showed the sand tank and explained the demonstration that was done with it. The class concluded with a showing of the CBS 60 Minutes interview with Anne Anderson, whose young son died from leukemia and who is a central character in *A Civil Action*.

Information from the interviews that were made in the *Lesson* for Class 4 and shared in the *Discussion* that week revealed that there might be subsurface pollution at the BTEX station that is located in the northwestern part of Moraine

Township. The *Lesson* for Class 6 was to make a Soil Gas Sampling Analysis (SGSA) along a transect from the BTEX station to the municipal well that provides drinking water to the residents of Moraine Township. The SGSA survey is a geophysical method of detecting whether there is gasoline floating on the surface of the water table. The *Assignment* was for each student to make a measurement at a selected point along the transect and report the result in the *Discussion* for everyone to use. *Questions* about Chapter 6 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation about the SGSA procedure, costs, and certification that is required before a measurement is made.

Because there was a positive SGSA result from the surveys in Class 6, the *Lesson* for Class 7 was to locate the underground storage tanks (UST) at the BTEX station. This is possible by doing a Magnetometry Metal Detection (MMD) investigation to locate the tanks before they are excavated. The *Assignment* was for each student to do the MMD survey in a square 10 feet on a side on the topographic map and to report the results to everyone in the *Discussion*. *Questions* about Chapter 7 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation about the MMD procedure, cost, and required certification before making the measurement.

After locating the USTs with the MMD survey, the tanks were excavated in Class 8. The *Lesson* for Class 8 was for each student to excavate the site he or she explored in Lesson 7. The *Assignment* was to expose the USTs and for ones that are leaking (LUSTs) to report the results in the *Discussion* for each student to add to the base map of Moraine Township. *Questions* about Chapter 8 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation about how to excavate an UST, the cost involved in doing that, and the certification required before excavation is begun.

In the *Lesson* for Class 9, the students were asked to review information that was obtained from the visual reconnaissance of Moraine Township, from interviews with business owners and their employees and from residents and government officials, the SGSA and MMD surveys,

and excavations at the BTEX station. The *Assignment* was to draw conclusions from the information as it applied to the LUSTs at the BTEX station and to share the conclusions with classmates and us in the *Discussion*. A second *Lesson* in Class 9 was to do a Ground Penetrating Radar (GPR) survey of the septic field at a former factory that is suspected to be the point source of the radioactive isotope tritium in the municipal water supply. As with the SGSA and MMD surveys, the sites for the GPR survey were assigned to different students. The *Assignment* was to report the findings of the survey to everyone in the course and to share it in a *Discussion*. *Questions* about Chapter 9 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation about how to do a GPR survey, the cost, and certification required before the survey is begun.

The students were back in the classroom for Class 10 where the sand tank was used for the *Lesson* about the migration of a plume of vegetable dye from a point source to a region of reduced confining pressure, which is a pond. The *Assignment* was to calculate the rate of flow of the plume using D'Arcy's Law and to share the answer with classmates in the *Discussion*. A laboratory activity was to measure the permeability coefficient of the regolith with a permeameter. *Questions* about Chapter 10 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation about the use of the permeameter to obtain the permeability coefficient that is one of the factors in D'Arcy's Law.

The *Lesson* for Class 11 was about radioactivity and the radioactive isotope tritium. The abandoned factory that will be the site of the proposed shopping center used tritium in the manufacture of some of its products. Because tritium is present in the drinking water used by residents in Moraine Township, it is important to find its source. Using the porosity and permeability constant of the regolith and the slope of the water table, the *Assignment* was to calculate the time in years that it would take for tritium to move in the groundwater from the factory to the municipal well. The answer to this assignment was shared in the *Discussion*. *Questions* about Chapter 11 in *Silent Spring* and *A Civil Action* were to be answered within seven days

and sent only to us. The *Resource* was a PowerPoint presentation about radioactivity and nuclides, especially of tritium and its decay product, a beta particle.

The *Lesson* for Class 12 was an examination of reports about the quality of the drinking water in Moraine Township. The *Assignment* was to summarize the information that is relevant for the Environmental Site Assessment Phase I Report that is a requirement of the investigation. Each student shared his or her interpretation of the reports with classmates using the *Discussion Questions* about Chapter 12 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation showing a Water Report and providing information about how to interpret the Report.

The *Lesson* for Class 13 was to test the groundwater in Moraine Township by obtaining water samples from drill wells. Drilling was done along a transect where there was a suspected plume of hydrocarbon contamination from the LUST at the BTEX station, and along a transect from the septic field at the abandoned factory that used tritium as an energy source in the manufacture of some of its products. The *Assignment* was for each student to drill at a site along the transect and to report the results in the *Discussion Questions* about Chapter 13 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* was a PowerPoint presentation that had instructions and guidelines about drilling so that money would not be spent unwisely at this phase of the investigation.

The *Lessons* for Classes 14 and 15, which were done in the classroom, were devoted to the writing of the Environmental Site Assessment Phase I Report that was a requirement of the investigation. The *Assignments* were for each student to draft a part of the report and share it with the entire class in the *Discussions*. Questions about Chapter 14 and 15 in *Silent Spring* and *A Civil Action* were to be answered within seven days and sent only to us. The *Resource* for Class 14 was a PowerPoint presentation with the instructions for the writing of the report. The *Resource* for Class 15 was a PowerPoint presentation that summarized the phases of the investigation and had instructions about completing the investigation, along with recommendations to be given to the prospective property owner regarding the environmental quality of the land being considered for the mini-mall. The course ended with a video that showed the

two brownfields in Moraine Township and a three-dimensional simulation of their movement to the municipal water well from the BTEX station and from the abandoned factory that used tritium.

Summary

In order to preserve the integrity of BA when it is taught online, it should be framed as a “hybrid” course, as it is important that the students meet together with the instructor for some of the classes. The asynchronous part of the course allows students to collapse time and space; to access the classes anywhere; to get immediate feedback, tutoring, and coaching; and to receive real-time interaction between themselves and the instructor. For anyone who teaches an online course or intends to teach one, a resource that we found to be useful is *The Complete Step-by-Step Guide to Designing & Teaching Online Courses* by Joan Thormann and Isa Kaftal Zimmerman (2012).

References

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About the Authors



Joseph Liddicoat is an Adjunct Professor at the City College of New York where he teaches the Core Science curriculum and elective science courses, one of which is Brownfield Action. Retired from Barnard College, he has been part

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Peter Bower, conservationist and educator, is a Senior Lecturer in the Department of Environmental Science at Barnard College/Columbia University, where he has taught for 29 years. He has been involved in research, conservation,

and education in the Hudson River Valley for 35 years. He is the creator of the Brownfield Action selected as a National SENCER Model Curriculum in 2003 and is a SENCER Fellow. This innovative curriculum includes a web-based, interactive, digital space and simulation, in which student “consulting companies” explore and solve problems in environmental forensics (see www.brownfieldaction.org). He has also developed and taught courses in field methods, environmental law, environmental hazards and disasters, waste management, energy resources, and the Hudson River ecosystem, among others. He is a recipient of Barnard College’s Emily Gregory Award for excellence in teaching. He has also served as acting executive director of the Black Rock Forest Consortium in Cornwall, New York, where he managed and directed the staff and facilities of a 3,785-acre forest and oversaw its research, educational, and conservation activities. He is the former Mayor of Teaneck, New Jersey, where he served on the City Council, Planning Board, and Environmental Commission for eight years. He received his B.S. in geology from Yale, M.A. in geology from Queens, and Ph.D. in geochemistry from Columbia. pb119@columbia.edu.

Supplemental Course Material

A. Class PowerPoints:

<https://serc.carleton.edu/download/files/65107/ClassPowerpoints.zip>

B. Class Lessons:

<https://serc.carleton.edu/download/files/65104/ClassLessons.zip>

C. Class Discussions (Forums):

<https://serc.carleton.edu/download/files/65101/ClassDiscussions.zip>

D. *Silent Spring* Questions:

<https://serc.carleton.edu/download/files/65110/SilentSpringQuestions.zip>

E. *A Civil Action* Questions:

<https://serc.carleton.edu/download/files/65098/ACivilActionQuestions.zip>

Link to Brownfield Action

<http://brownfield.ccnmtl.columbia.edu>