

Pedagogical Techniques Employed in a Freshman Seminar Course (Environmental Hazards)

Simon T Ghanat

Associate Professor, The Citadel

Abstract

Various active learning techniques were employed to improve students' learning environment in a Freshman Seminar course at The Citadel. These included employing case studies, facilitated discussions, peer teaching, project, field trip, formative assessments, literature research, debates, and poster presentation. A pre- and post-test was developed based on key concepts in environmental hazards to assess the knowledge gained over the course of the semester. The pre-test was administered to measure student's prior knowledge at the beginning of the term. The same short-answer test (post-test) was administered on the last day of the semester to assess knowledge gained as a result of the course experience. This paper discusses the active learning techniques employed and the analyses of pre- and post-test results.

Keywords

Freshman Seminar, General Education.

Literature Review

General education is rooted in educators' belief that its courses should teach students knowledge for life¹. More specifically, it should develop skills that foster students' achievement in their academic pursuits and beyond². In a broader sense, it can offer a variety of learning experiences to educate students on how to be responsible, caring members of society³. Because of their general education, students should be better able to view diverse cultures, lifestyles, and backgrounds from objective and informed perspectives². It is no surprise then that colleges and universities persist in general education curriculum inclusion as a way to fulfill their institutional missions.

General education, in a broad sense, is comprised of a grouping of courses in the liberal arts. At some institutions, this grouping is a set of prescribed courses more focused on skills development. At others, it is a selection of elective courses from each area designed to broaden perspectives⁴. The goal is to provide a greater appreciation and understanding of human civilization beyond the discipline-specific depth found in a particular field of study. However, students often view courses that fulfill a general education requirement as unnecessary or not related to their interests or major⁵. They do not see the relevance of such courses and sometimes contribute minimal effort to understanding the material and making connections to other fields of study, including their own academic major. This can be manifested in the general education classroom with superficial dialogue, distracting behaviors, and even poor attendance. In response, those involved in developing the general education curriculum want to offer courses

that motivate students and engage them in learning⁶. This is a sound approach given that students tend to do better in courses that they find more interesting⁷.

New General Education Courses at The Citadel

The Citadel is developing a new general education program. Known as a high impact practice, the Freshman Seminar has been credibly shown to improve student retention and enhance student learning. The Freshman Seminar will serve as the common starting point for all entering freshmen. The overall theme of the seminar, as well as the topics of the individual seminar sections are determined by the faculty. The new plan calls for each section of the Freshman Seminar to be matched with a three-credit-hour composition class. The composition class is an essential complement to the academic seminar. The instructor of the composition class and the instructor of the seminar develop together their reading lists and assignments. The intention here is to maximize each student's development in the Written Communication outcome by taking advantage of his or her interest in the seminar topic.

In spring 2019, the school of engineering piloted a freshman seminar course titled Environmental Hazards. The course instructor employed wide varieties of active learning techniques to enhance the Freshman Seminar course and to improve the student-learning environment. These included employing case studies, facilitated discussions, peer teaching, a project, a field trip, formative assessments, debates, and a poster presentation. The course instructor also developed a pre- and post-test based on key concepts in environmental hazards to assess the knowledge gained over the course of the semester. The pre-test was administered to measure students' prior knowledge at the beginning of the term. The same short-answer test (post-test) was administered on the last day of semester to assess knowledge gained as a result of the course experience. This paper discusses the active learning techniques employed and the analyses of pre- and post-test results.

Pedagogical Techniques used

The course instructor employed four case studies related to water contamination (Love Canal, A Civil Action, Flint Water Crisis, Erin Brockovich) during the semester. Following is a brief description of "A Civil Action" case and the corresponding facilitated discussion.

"A Civil Action", a groundwater contamination case study, was used to assess students' understanding of the steps needed to determine if a water source is contaminated, how it became that way, and to suggest possible methods of cleanup or remediation. Students were asked to review a portion of the film and identify the problem and the people involved. Students were required to apply their knowledge of water and hazardous waste contamination to create a plan to help lawyer in the film try the case. Students discussed the following questions in teams of three: What is the problem? Who is affected by the problem? What are some things that they already know about the case? Students re-examined their list of "knowns" and identified the "assumptions." This was a great opportunity to discuss the use of evidence in science versus basing conclusions on emotion or previous experiences. Students were asked to focus on the fact that they were trying to determine what was causing the illnesses in the children. How should they test the water to determine where the TCE came from? How could they be sure about who caused the contamination? What could industries that caused the contamination have done to

prevent this disaster from happening? What would they do if they were the lawyer in the case — take the case or not? Why or why not? What factors would they use to help them make their decision?

The instructor employed web-based pre-class reading responses⁸ to motivate students to prepare for class regularly. Students were required to respond to one open-ended question on the course website prior to each lesson. Before each lesson, student responses were examined and the in-class activities were tailored to meet their actual needs. At the beginning of each lesson, pre-class reading responses were summarized on the board and common errors were discussed.

To assist students with learning of the course material and to promote active learning, each student was required to teach a lesson during the semester. This method can benefit both those students who are being taught and the peer teachers⁹. Peer teachers can reinforce their own learning by instructing others and students feel more comfortable when interacting with a peer⁹. Short YouTube videos were shown daily to facilitate and stimulate some introductory discussions on each day's topic.

The instructor used formative assessment (i.e., one-Minute paper¹⁰) to monitor student learning and address students' misconceptions and preconceptions. Students were typically asked to write a concise summary of the presented topic, write an exam question for the topic, or answer in 60 seconds a big picture question from the material that was presented in the current or previous lesson.

In-class debates cultivate the active engagement of students, placing responsibility of comprehension on the shoulders of the students¹¹. Debates afford many benefits besides promoting active engagement and mastery of the content¹¹. Because debates require listeners and participants to evaluate competing choices, they develop higher order critical thinking skills by moving up Bloom's Taxonomy^{11, 12}. For these reasons, the instructor employed debates of ethical dilemma case studies to further facilitate active learning and promote critical thinking skills.

Semester Project: Revitalization of a Brownfield site near campus of The Citadel. A brownfield site is any real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant¹³. The following is a brief description of the assignment. Demand for prime real estate in nearby communities has significantly increased in the last few years. City officials are looking for solutions to solve the problem and have contacted you to prepare a proposal for a Brownfield site redevelopment study. Each team must prepare an engineering proposal on the Brownfield site redevelopment study to be submitted to city officials. The proposal should include the following: detailed scope of work; management plan; task descriptions; schedule of tasks; budget table; project benefits; economic benefits; tables, figures, drawings; and cost of redevelopment. Table 1 shows the project timeline and tasks associated with it.

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Table 1. Timeline and tasks associated with project.

Timeline	Tasks
March 19/2019	Redevelopment proposal project was assigned.
March 21/2019	<p>Field Trip</p> <p>Students visited the nearby brownfield site. Students obtained a first-hand experience investigating the site; measured the dimensions of the site; and interviewed the residence in the community.</p>
March 26/2019	<p>Research-Computer Lab</p> <p>Students investigated the community need and demographic information. Students also discussed their positions on site remediation (Is site cleanup necessary)?</p>
March 28/2019	<p>Research-Computer Lab</p> <p>Students examined the brownfield site and its effect on the community. Students investigated information about past land uses and site activities, potentially related environmental issues, or contaminants, and current conditions.</p>
April 2/2019	<p>Research-Computer Lab</p> <p>Students described the project, its implementation, and the redevelopment strategy for the site. Students investigated several soil and groundwater remediation technologies. Students estimated the cost of remediation and the amount of time needed.</p>
April 4 and 9 /2019	<p>Research-Computer Lab</p> <p>Students described the project management approach by listing the tasks required to implement the proposed project, and estimated the cost for each task.</p>
April 11 and 16 /2019	<p>Students described the anticipated outcomes and benefits expected from the project in the context of the needs. Students described residents' health and/or welfare; economic benefits and/or other non-economic benefits; and planned efforts to promote local hiring.</p>
April 18 and 23 / 2019	<p>Students finalized the proposal and created posters.</p>
April 25/ 2019	<p>Students presented their posters. A sample poster is shown in appendix.</p>

Study Methods

The dataset of student results on the pre- and post-test instruments, coupled with pedagogical techniques, allow for an opportunity to assess student’s prior knowledge and learning gains. The following describe the guiding research questions for this study: (1) to what degree, do first year students have exposure to environmental hazards concepts prior to taking this course? (2) What do the students gain in conceptual understanding about environmental hazards from the beginning of the course to the end?

Assessment Measure

A ten-question background knowledge probe (pre-test) and course knowledge survey (post-test) were developed based upon the key concepts related to environmental hazards (Table 2). The pre-tests were administered to measure students’ prior knowledge and to identify student misconceptions at the beginning of each semester. The same short-answer test was administered on the last day of the semester to assess knowledge gained as a result of the course experience. It is important to note that neither the pre-test nor post-test counted toward the course grade. In this study, the term ‘learning’ refers to actual improvement in measureable knowledge regarding environmental concepts.

Table 2. The short-answer questions on the pre- and post-test

No.	Question
Q1	What is groundwater?
Q2	Where does groundwater come from?
Q3	How important is groundwater?
Q4	Name two sources of groundwater pollution.
Q5	What are the effects of groundwater contamination?
Q6	Name two major groundwater contamination cases in the United States
Q7	Name one toxic inorganic and one toxic organic chemical
Q8	What is EPA?
Q9	What is CERCLA?
Q10	What is NPL?

Results and Discussion

Figure 1 analyzes students’ performance on each question on the pre-test and post-test. Student performance on the pre-test is indicating little to no prior experience with these concepts. The strongest scores on the pre-test were Questions 5 and 8 (assessing effects of groundwater contamination and the term EPA, respectively). The weakest scores on the pre-test were Questions 9 (what is CERCLA), 10 (What is NPL?), and Question7 (naming a toxic organic and inorganic chemical). The scores increased on all of these questions for the post-test, although the scores for Question 9 were still slightly low.

The strongest scores on the post-test were Questions 4, 6, and 8 (perfect for all students); these questions were all fundamental course concepts that are highly emphasized throughout the semester: sources of groundwater pollution, major groundwater contamination cases in the United States, and the EPA, respectively. The weakest scores on the post-test were Question 9 (CERCLA) and Question 10 (NPL).

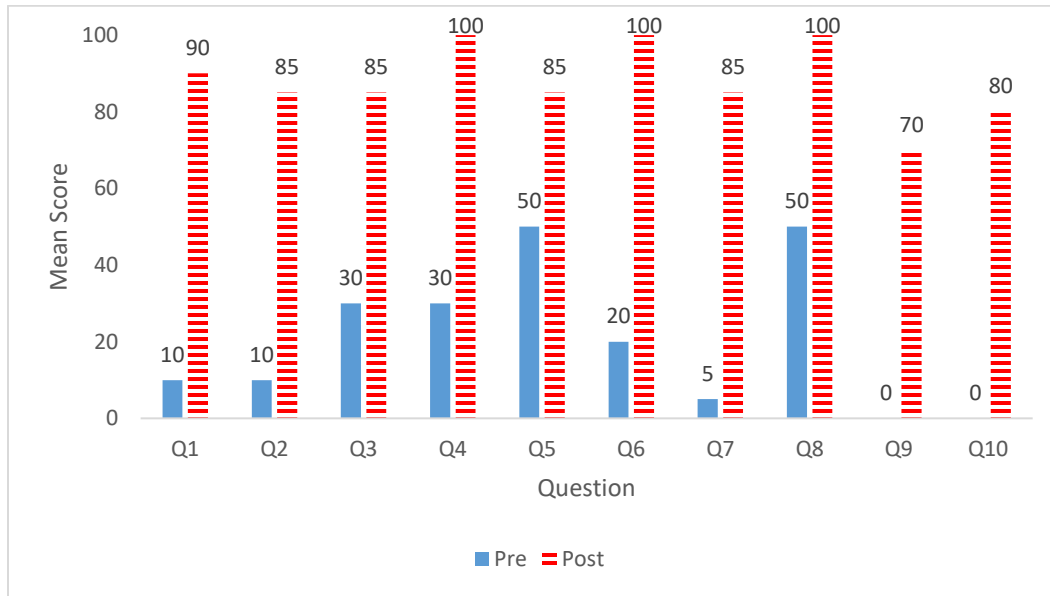


Figure 1. Mean score for each question on the pre- and post-test

A statistical analysis was conducted on pre- and post-test data to detect changes in students' understanding of the concepts over the course of the semester. The difference between the means was statistically significant for each question, showing substantial improvement from pre-test to post-test at five percent level of significance. The results showed that there was a significant difference in scores for pre- and post-test. There was an increase from an average score of 21.6% on the pre-test to an average score of 86.9% on the post-test ($p\text{-value} < 0.001$).

Conclusion

To help first-year students at The Citadel gain a richer depth of knowledge, a seminar course has been designed. This was accomplished by choosing the appropriate assessments, projects, and activities specifically designed to enable the students to achieve those goals. Students are entering a freshman seminar course with little prior knowledge about environmental hazards. The low performance on several of the pre-test questions is not surprising, as students are not expected to have wide exposure to these concepts prior to completing a course in environmental hazards. Students demonstrated improvement in understanding of environmental hazards concepts during the course.

It is important to note that the results of this study are limited to one semester and should not be generalized to draw broader conclusions. Further data collection and analysis is warranted over the next few offerings before conclusions can be made.

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Simon T Ghanat, Ph.D., PE

Dr. Ghanat is an Associate Professor of Civil and Environmental Engineering at The Citadel. He received his Ph.D., M.S., and B.S. degrees in Civil and Environmental Engineering from Arizona State University. His research interests are in engineering education, seismic site response studies, engineering characteristics of strong ground motions, and probabilistic seismic hazard analyses. He previously taught at Bucknell University and Arizona State University.

