Study of Prior Exposure to Environmental Hazards Concepts

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Abstract

As a requirement for graduation, students at The Citadel must take a Freshman Seminar course in their first semester. One such course is Environmental Hazards which is offered by the Civil Engineering (CE) Department. A background knowledge probe (pre-test) was developed based on key concepts related to soil and groundwater contaminations. The pre-test was administered at the beginning of the course to measure student's prior environmental hazards knowledge and to identify student misconceptions at the beginning of the term. This study examines the pre-test data from sections of Environmental Hazards taught in 2020-2021 at The Citadel.

Keywords

Freshman Seminar, Concept Inventories

Background and Institutional Context

Concept inventories are a key component in evaluating student learning and assessing how well students have mastered concepts of a course. The assessment process begins at the start of course, when students are given a background knowledge probe, such as a pre-test.[1-3] The pre-test provides a baseline that is vital to assess a student's mastery of course concepts when utilizing another knowledge probe at the end of the course, a post-test.[1-3]

The Citadel has developed 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[4]. The Freshman Seminar serves as the common starting point for all entering first year students. The fundamental purpose of Freshman Seminar is to improve students' abilities in inquiry and analysis, critical thinking, written communication, quantitative literacy, intercultural knowledge, and ethical reasoning.[4] The overall theme of the seminar, as well as the topics of the individual seminar sections, are determined by the faculty. The new general education program 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 goal of the new general education courses 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, CE faculty piloted a Freshman Seminar course titled "Environmental Hazards".

The guiding research questions for this study is: To what degree do first year engineering students at The Citadel have exposure to environmental hazards concepts prior to the freshman seminar course?

Assessment Measure

A ten-question background knowledge probe (pre-test) were developed based upon the key

concepts in Freshman Seminar course (see Table 1). The pre-tests were administered to measure students' prior knowledge at the beginning of each semester.

Table 1. Pre-test survey administered on the first day of semester.

Q1	Where does groundwater come from?
Q2	Why do you think areas dominated by minorities and the poor are sites chosen for the disposal of hazardous waste?
Q3	What is environmental justice?
Q4	What are the effects of groundwater contamination?
Q5	Name one major groundwater contamination case in the United States.
Q6	Name one toxic inorganic and one toxic organic chemical
Q7	What is EPA?
Q8	What is CERCLA?
Q9	What is NPL?
Q10	What is the difference between a superfund site and a brownfield site?

Results and Discussion

The course instructor used an established solution to the instrument. Instructor scored each of the ten questions using the following standardized rubric: awarding a score of zero (0) for an incorrect, off-base answer or no answer at all; awarding a score of 0.5 for a partially correct answer; or awarding a score of one (1.0) for correct answer. For students, these open-ended questions require higher-level cognition and synthesis. For instructor, these questions require greater interpretation and judgment when determining acceptable solutions.

Figures 1 and 2 provide an overview of students' prior understanding of environmental hazards concepts in the seminar course. Figure 1 illustrates the engineering majors' performance vs. the other majors on each question on the pre-test. Engineering majors were outperformed on questions 1 through 7 by the students from the other majors. Engineering majors (i.e., Civil and Mechanical engineering students) and other majors (i.e., Biology, Chemistry, Intelligence Studies, and Business students). The percentage of students that correctly responded to Questions 1, 2, 3, 4, 5, 6, and 7 ranged from ten to seventeen, thirty-five to forty-four, twelve to nineteen, eighteen to twenty-five, forty-eight to fifty-three, forty to forty-eight and forty-five to fifty, respectively. No student correctly answered Questions 8, 9, and 10. Student's high pre-test performance on certain questions suggests that they are sufficiently able to apply their prior knowledge to certain aspects of environmental hazards. The question with the highest pre-test

score (Question 5) concerns the groundwater contamination case in the United States. Two other questions with high performance are Question 6 (toxic organic and inorganic chemicals) and Question 7 (EPA). This may indicate student familiarity with environmental engineering/science issues from popular news but a lack of real exposure to environmental hazards regulations and processes.

Figure 2 depicts that there were some considerable differences between students' pre-test scores for male and female in this study (most notably on Questions 2 and 3), although the performance on other questions was similar. The differences in Figure 1 are not as predominant as those in Figure 2, suggesting that the distinction between engineering majors vs. other majors is smaller than male vs. female with regards to students' prior understanding of environmental hazards concepts. One question with a notable difference in Figure 1 is Question 2, in which students from other majors displayed a stronger understanding of why areas dominated by minorities and the poor are sites chosen for the disposal of hazardous waste than engineering majors.

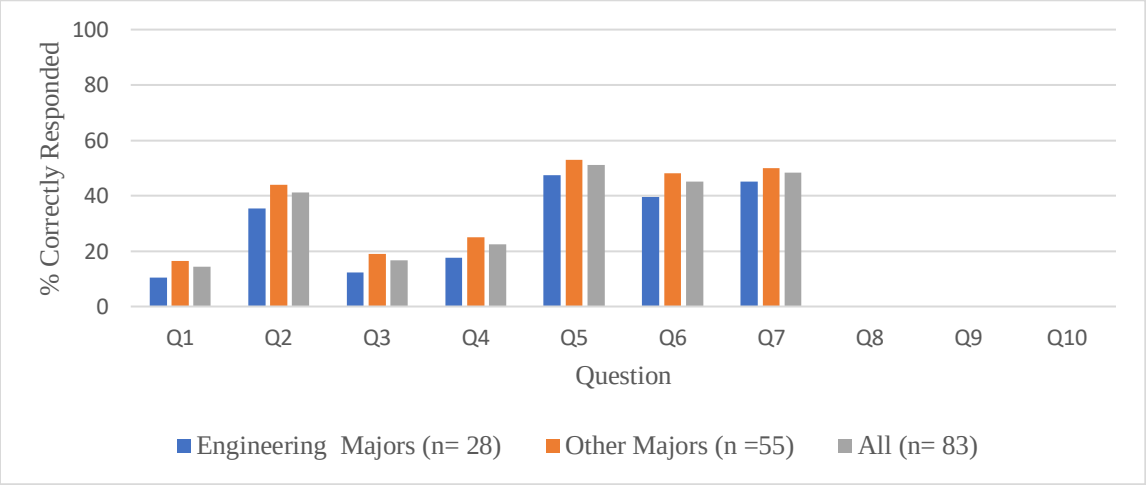

Figure 1. Engineering majors' performance vs. other majors on each question in this study.

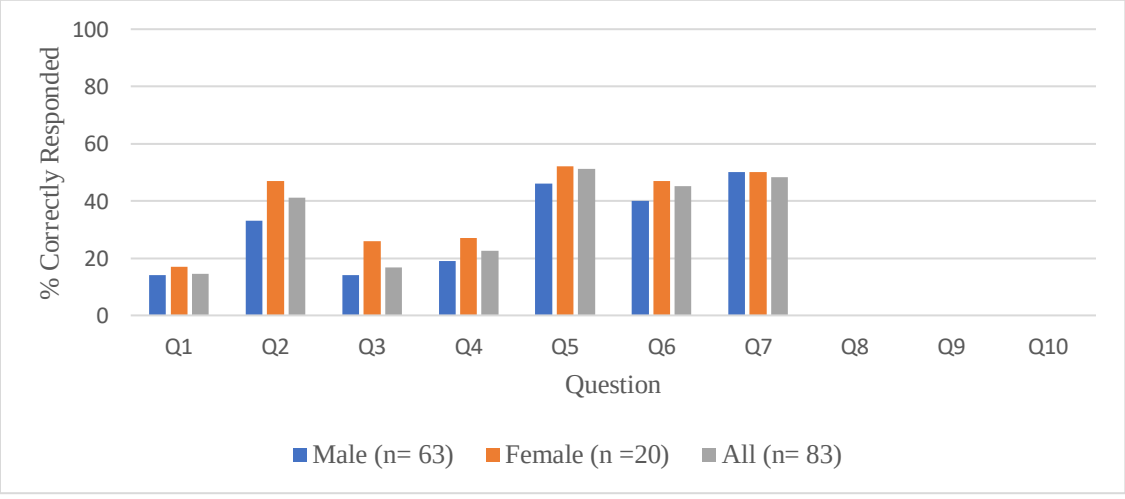

Figure 2. Students' pre-test scores for male and female in this study.

A two-sample t-test statistical analysis at five percent level of significance ($\alpha = 0.05$) was conducted to see if there is a significant difference between the mean performances of the engineering major and other major. The results showed that performance difference between the Engineer major and other major was not statistically significant.

Conclusions:
This study assessed the amount of exposure first year students have to Environmental Hazards Concepts prior to this course. The following conclusions can be made based on the study results:

- Students are entering Freshman Seminar course with little prior knowledge. 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.
- It is important to note that the results of this Work-In-Progress study are limited to the two years (with N = 83 student samples) assessed 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.

References

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