ASSESSMENT OF THE USE OF HIGH PERFORMANCE CLASSSROOM COMPUTING IN UNDERGRADUATE EDUCATION

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1. INTRODUCTION

Exercises to improve student's decision-making skills and learning have been limited to small scale environmental quality issues presented in the classroom. The broader, more complex, large scale problems have not been introduced to students for enhanced understanding of scaling issues. With recent developments of web-based models and spatial tools, students have been exposed to less complex issues involving various environmental quality scenarios. Large scale problems, such as state, regional, and global environmental issues are more difficult to incorporate into student learning exercises with present models. In this project, undergraduate student's learning and decision-making using high performance classroom tools were assessed using a web-based interface linked to a complex model. This tool aided in bridging the gap between models and enhanced student learning. The expectations were that students would improve their decision-making skills by solving realistic, complex, and large scale environmental issues. This was made possible through faster computation time, enormous datasets, larger scale, easy to use web interface, and predictions over longer time periods using the Century Soil Organic Carbon Model (Partan et al., 1988). Teaming up with Purdue's Research Computing and Teaching and Learning with Technologies group in utilizing their supercomputer for faster computational time while modeling carbon sequestration; the USDA-ARS developed Century Model was chosen as a simulation tool for soil carbon sequestration.

A field scale environmental quality models was scaled to cover large spatial areas over long time periods. This spatial and temporal scaling required high computational power which demanded the use of supercomputers. Supercomputing coupled with large scale complex models have further helped predict and improve policy analysis at the region, state, and city level. Employing supercomputing as a tool for better understanding of environmental modeling examples, real-life situations that were too complicated to present to the students in the past, can now be added to the curriculum. The uniqueness of this project lies within the scaling and supercomputing proposed to analyze carbon sequestration practices across the US. Scaling from one watershed to many watersheds within the United States was used to analyze the effectiveness of current, past, and future carbon sequestration practices. Scaling the model from smaller areas to larger areas while changing few area specific parameters provided a unique scaling approach where current modeling capabilities in classroom modeling are limited to simulate one area (watershed) at a time. The scaling proposed in this project allowed several areas to be modeled and analyzed simultaneously while altering parameters for comparison and contrast on the best efficient practices to achieve the target environmental goal (in this case crop, tillage system, soil texture and climate).

Furthermore, students in engineering have various expectations that need to be met once they have completed their undergraduate program. One of those expectations includes an awareness of real-world/complex issues and the decisions involved (Raju and Sankar, 1999). Raju and Sankar found that incorporating these real-world issues into the engineering curriculum was a catalyst for funding agencies and educators on the need to develop interdisciplinary technical case studies. Hence, the students were able to bridge the gap between theory and practice while becoming aware of these issues and issues that may arise in the future.

In essence, the goal of this research was to assess student learning and decision-making skills through high performance classroom tools. Students were able to assess the impacts of climate, soil texture and management on carbon sequestration. The hypothesis stated that understanding large scale environmental modeling will enhance student learning and decision-making skills.

2. METHODS

The initial study took place in the Fall semester of 2004 at Purdue University, West Lafayette, IN Campus. The study group consisted of 36 Purdue students enrolled in two courses offered by the Agricultural and Biological Engineering Department. The two courses chosen were: 1) ABE 325 (Soil and Water Resource Engineering) - interrelationships of the plant water-air-soil system; hydrologic processes; protection of surface and ground water quality; GIS targeting of soil and water protection measures and 2) ASM 336 (Environmental Systems Management) - analyze environmental systems with special emphasis on non-urban and agribusiness needs, global environmental issues, water and air quality, soil and water conservation, regulatory and policy issues using computer-based tools which are housed in the Agricultural and Biological Engineering Department and were junior/senior level courses. These courses were chosen because they contained environmental engineering educational material as well as using environmentally-impacted computer models to analyze data as well as topics surrounding global warming and its impact. The study group consisted of 8 females and 28 males where the majority of the group was from rural and European backgrounds. The two courses met at different times and assurance was made that students were not enrolled in both courses. The two course professors were aware that their students would not be abreast of the topic of carbon sequestration and therefore thought that students would benefit greatly from the experience. Each professor was given an individual meeting, where the guidelines and procedures were outlined, as well as, a copy of the lecture, pre/posttest, scenario assignment, website that housed the model, and the survey questions. The professors were also asked if the questions on the handouts were appropriate for their students (if the questions were too easy or too difficult as to not incur a floor or ceiling effect in the results), and after approval a timeline was established for carrying out the experiment.

During the data collection, the students were first asked to sign a Human Subject Consent Form before given the pretest, to ensure there voluntary status and also give them justification for the study. The students were given a total of seventeen minutes to complete both the consent form and the pretest. The pretest consisted of idea-extracting, decision making, and multiple choice questions. After the pretest the students were given a twenty five minute lecture on carbon sequestration, global warming, greenhouse gases, and its impact. During the presentation the computer model that the students would be using to complete the scenario assignment was introduced as well as sample simulation shown. At the end of the presentation the students were given an assignment that required the use of the computer model. The students were given a small scale scenario assignment or a large scale scenario assignment. This was done because the goal of the research was to assess if students performing the large scale modeling scenario assignment had enhanced decision-making skills and would greatly increase their score from pretest to posttest. During the simulation the students were given a web-based survey that asked questions regarding what they learned, technical difficulty and, the effects on their decision making. The professors also incorporated the scenario assignment into the student's overall class grade, in order to ensure that the students would do the assignment and participate in the study. The students were given one week to complete the assignment. After two weeks past from receiving the scenario assignment, the students were given a fifteen minute post test that was similar to the pretest, which was used to measure change in the scores.

3. PRELIMINARY RESULTS AND DISCUSSION

The preliminary results revealed that the students were not very abreast of carbon sequestration. Viewing the pretest scores, it was deduced that the student's decision-making and learning skills required enhancing. Observing Figure1, the pretest scores appear skewed to the right, while the posttest scores were skewed left, which was to be expected. The students should have increased their score from pre to posttest due to the added benefit of hearing the lecture as well as running the model and completing the scenario report. In comparing the two courses on all three assignments in Figure 2, it appears that the ABE 325 course scored higher. This coincides with the hypothesis that the ABE 325 course would score higher, because the students had more experience in running models and being able to interpret results. Figures 3 and 4 (ASM 336 and ABE 325) respectively reveal the two courses comparing the large scale and small scale groups in the three assignments. The results show that large scale initially had lower scores on the pretest but finished ahead of the small scale group in the scenario assignment and the posttest score. The opposite occurred for course ABE 325, where the large scale initially had lower scores on the pretest but did not exceed past the small scale group on the scenario assignment or on the posttest. For figures 5 through 7 respectively, the results display gender comparisons within both courses comparing females vs. males, where females continuously scored higher than the males on all three assignments and males compared to overall mean had lower scores while females as compared to the overall mean had higher scores.

The following figures reveal mean scores of the dataset. These results are implications and forecasters of what will be altered for future use and also to offer a broad interpretation of the results so far. Currently, trends in the responses to the questions reveal that rewording of the questions may foster more conclusive results. This study served as the initial study in Fall 2004 and a similar study is currently underway, using the same concepts, but with improvements.

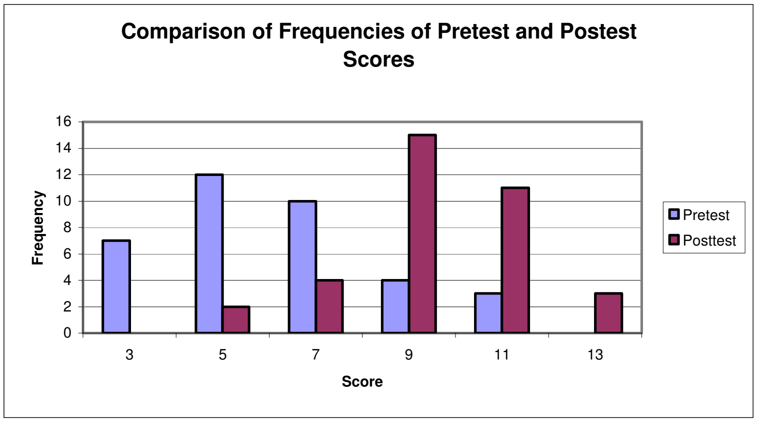

Figure 1: Frequency distribution of pretest and posttest scores.

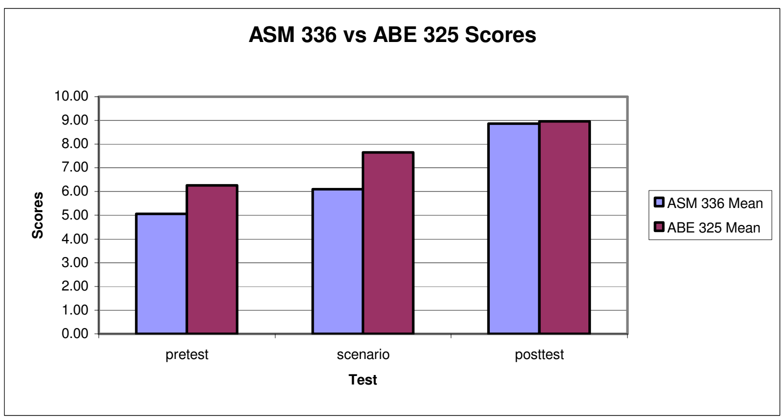

Figure 2: Mean comparison of both courses for pretest, scenario, and posttest scores.

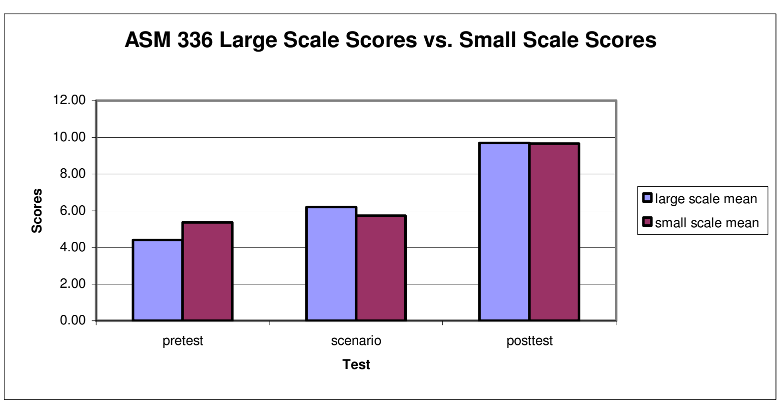

Figure 3: ASM 336 mean comparison of large scale vs. small scale for pretest, scenario, and posttest scores.

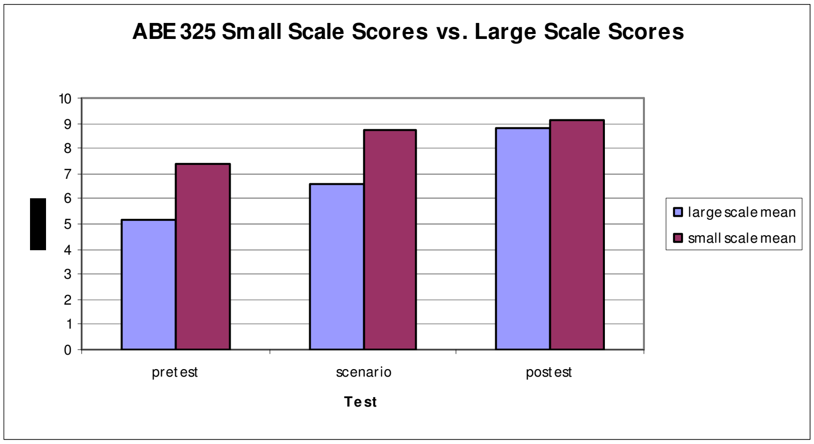

Figure 4: ABE 325 mean comparison of large scale vs. small scale for pretest, scenario, and posttest scores.

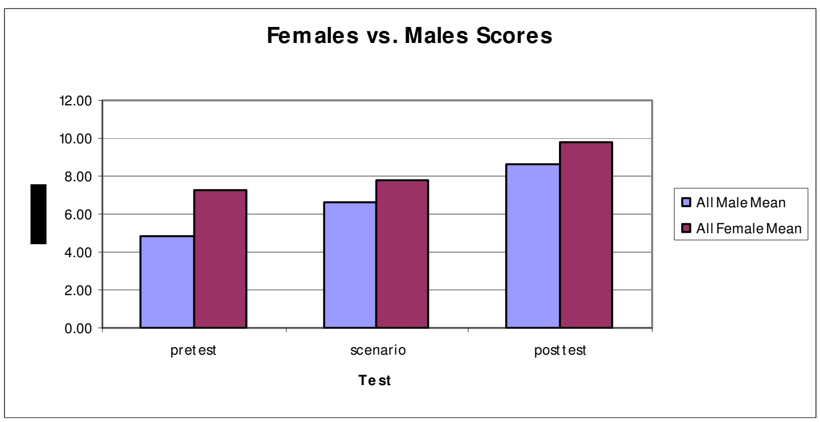

Figure 5: Mean comparison of males vs. females in both courses.

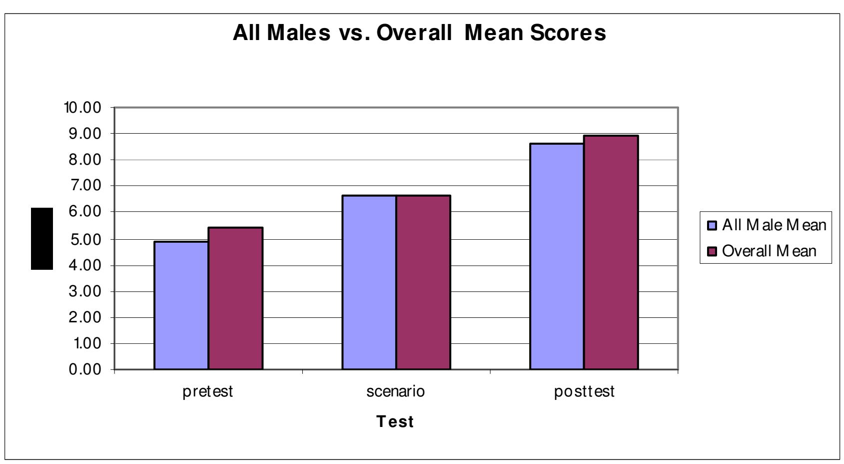

Figure 6: Mean comparison of males vs. overall scores.

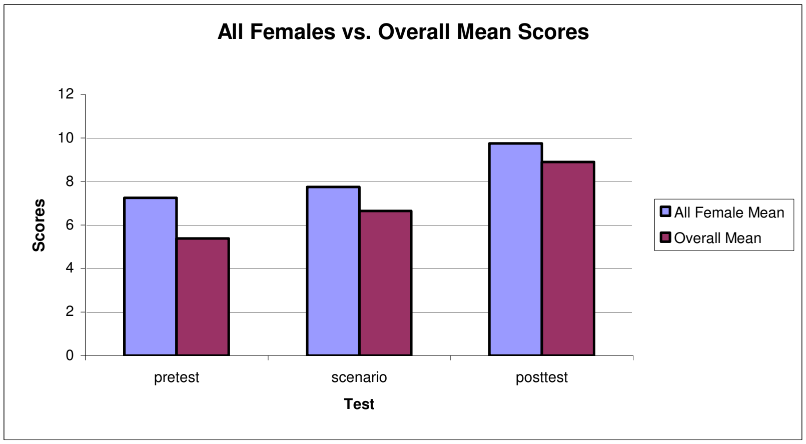

Figure7: Mean comparison of females vs. overall scores.

Applying statistical analyses revealed that there were no significant differences in gender, course, large or small scale scenario assignment, or pre/post test scores. It was also found that there was no linear relationship or pattern in pre/post test scores. Originally it was thought that the pretest should be used as a co-variant in an ANCOVA model. This was thought because of the difference in the two courses and the level of ability, so the pretest would be used to even out the two courses. An ANCOVA is used to increase power in a one-way or two-way ANOVA by adding a second or third variable as a covariate. It is can be used to control for initial differences in pretest scores and removes "covariate bias" or "selection bias", which weakens internal validity (http://carbon.cudenver.edu/~lsherry/rem/ancova.html, March 2005). After applying the power rule to the data set, the results showed that in order to detect significant differences in gender, course, large scale/small scale assignment, and pre/posttest scores, approximately 280 participants was needed. As a result of this finding, there will be three additional courses added in Spring 2005 totaling the number of participants to approximately 300.

4. CONCLUSIONS

Limitations to the study were in wide abundance. The main limitations included time limit, number of classes and the number of students. Since the courses were under constraint to teach the required syllabus, time allowed to interact with the students was limited; especially with the survey portion of the study. The survey was limited because of student response rate, students taking the time to put thought into the actual responses they provided. A focus group would have been ideal, but due to the number of participants, IRB (Human Subjects) and the time constraints that would not have been an effective data collection. An online survey was administered in fall 2004 as a way to generate a “forced” student response. This was done by placing the survey on the model website. The survey appeared after student ran the scenario simulations, and they were not able to obtain their results unless they completed the survey. This method did not prove to be effective, in that in order to receive plausible responses the student would need to have done the report/assignment first. As a result, the survey was then given as a hand written assignment immediately following the posttest. The number of questions was reduced in order to alleviate any pressure on the student from having to already complete the posttest. Also, this method also gave an enhanced quality to the responses from the students because now they can expound on the entire process and be able to give their perceptions of the project as a whole.

Since there was a large sample a class interview was also ruled out due to "dominant" students only speaking and therefore hindering responses from "shy" students and also leaving out numerous responses leaving a low quality data collection. Finally, it was apparent that the majority of the students increased their score from pretest to posttest and felt that the study was beneficial to their learning and decision-making skills. Overall, the impact of the study indicated that another data collection would be needed to garner effective statistical analysis and arrive at more conclusive notions.

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http://carbon.cudenver.edu/~lsherry/rem/ancova.html, March 2005