

**ASSOCIATED COLLEGES OF THE SOUTH
TECHNOLOGY FELLOWS PROGRAM**

REPORT

TEACHING CALCULUS WITH TECHNOLOGY

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DESCRIPTION

The project was mostly developed and conducted in the PC laboratory and the new SUN laboratory of Mathematics Department, Morehouse College, sponsored by Morehouse College's Information Technology office and a matching grant from SUN Microsystems, to promote teaching as well as faculty and student research. The Principal Investigator is supervising the administration of the laboratories.

The project started from building up an on-line web based learning and tutoring system for calculus classes. The system was installed on the SUN Soloris web server. Most of the source files are html files with JavaScript embedded, while some other features, such as log in and certain graphics, use java applets. A student assistant, Mr. Michael Page, was hired as the laboratory attendant to supervise student activities in the laboratories and collect data. Students in the Analysis I and II classes PI was teaching during Spring and Summer, 2002, participated in this research project.

The schema of the project primarily has four components: initial login; material review, self-test and on-line test. Only students with appropriate authorization can use the system. Accounts were issued for each participating student. After login, students can select the chapter or section they wish to start with. In each chapter or section, one can choose to review the material and concepts, or self-testing, or take an on-line test and the system reports the results to Mr. Page as a reference of student class performance.

In the Review component the system provides a dynamic, interactive and graphical user interface to explain the concepts for each section. User can go back and forth to learn and understand the concepts until they feel comfortable and fully understand. For example, with the concept of limit that is one of the most difficult topics in beginning level Calculus course, system puts a function curve on the screen. When user uses mouse to approach any point along the curve, both x and y coordinates appear when the cursor moves. They can see exactly how y coordinate changes when x moves. Another example is the definition of continuity and derivative. User can see how slope of the secant line approaches to slope of the tangent line by looking at the animated display on screen.

In the self-testing component, the system randomly takes problems from its bank,

selected by instructor, and a digital clock is at the corner for timing purpose. For each problem, if user gets the right answer it will move to next problem, otherwise it can ask user to re-try. After several unsuccessful attempts, the system will prompt the answer with explanation. At the end of each test, the system produces a detailed report of the results, including the correct answer for each problem and user's input, how many attempts was made, time for each problem and total time of the test.

In the on-line test component, problems are selected from the same bank. The format and the number of the problems as well the types of the problems was chosen to be very similar to the regular Analysis I and II classes for the purpose of comparison and study. Students were not given the chances to re-try any problems, and the scores were reported back to PI, as a measurement of their performance.

As the program proceeded, the database of testing problems was significantly expanded by adding a large number of the problems, and a few bugs were reported and fixed. Though the system is still at the trial stage but with this research program it has run much more stable and smooth compared to its debut launching.

ANALYSIS

In this project, two models were used for the purpose of comparison and study: "traditional" vs. "Online system". Students from three classes participated the project: Analysis II, Spring, 2002 and Analysis I & II, Summer, 2002. Data from previous semesters were also used for analysis. Because of the small sizes of the samples, it would not carry very much official statistical weight, but all numbers seemed to look very encouraging for future exploring in this direction. The most import impact of using the system is the enhancement of students' performance and their involvement with calculus study. Final data shows that over each test the scores are in average approximately 19% more than those who took the traditional handwriting test, with the same multiple choice format and similar set of problems. Overall, by looking at their total scores at the end of each semester, they are in average 17.5% higher. Also the total amount of time students spent on studying the subject is 16% more than those who did not use the system. One theory is that the total amount of study time is proportional to class performance, but it can also be said that credits should be given for attracting students to study. From student feedback after using the system what they benefited most is the graphic interface of the program, especially when study the concepts of limit and derivatives, and also the constant standby availability of the system. Among many, one of the unknown factors in the study is the use of multiple-choice format rather than user input, because of the limitation of available resources. The results would have been much more convincing if other formats were also used in the study. Technically, allowing users to input their various answers and making those answers understood to the system would be exponentially more difficult to implement and require much larger size of both financial and human resources.

In conclusion, it is believed that more and more technology will be used in the classrooms. It is no longer a question of if, it is a question of when and how. Technology will never ever substitute human teaching in classroom and it should not, but introducing technology into classrooms will certainly benefit students in any measure.

DISSEMINATION

The source codes of this project are open and free for ACS faculty and students to share and use in classrooms and for educational purpose only, excluding any commercial usage. A web site on Morehouse Mathematics Department server is available to ACS faculty and students for browsing. The results of this study are in the process of editing for publication. Suggestions and comments are solicited and extremely appreciated. Collaborators for further research in this area are very much welcome.