TESTING ACROSS PRECALCULUS SECTIONS USING WEBASSIGN

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The mathematics department at the University of Georgia (UGA) has a long-standing tradition of standardized, electronic testing for all sections of precalculus. The department recently transitioned to a new assessment platform. WebAssign® is a commercial product developed at North Carolina State University, and it provides enough flexibility to serve the needs of the precalculus curriculum at UGA. This paper will outline the assessment procedures in place for precalculus courses at UGA and the role of technology in that assessment.

Each year approximately 58 sections of precalculus are offered at UGA over 3 semesters. With total enrollment approaching 2000 students, the department felt the need to develop a plan to ensure some uniformity in the assessment of student learning. In other words, the department wanted some consistency in the level of understanding and proficiency demonstrated by a student who earned an A grade (or B or C or D) in any precalculus section. Over the years, a homegrown testing software platform was developed, with homework, quizzes and tests generated to coincide with the content and questions of the adopted text. A platform change was necessitated by growing pains related to the underlying operation systems available on modern desktop PCs. After testing several platforms during an experimental phase, the decision was made to switch to WebAssign.

The curriculum for precalculus is designed to serve three major groups of students. There are students who need a mathematics core course: while precalculus is not the recommended choice for such students, it is one option. There are also students preparing for calculus: one group who will take a terminal calculus course (primarily business and biology majors) and one group who will take several sequential calculus courses (students majoring in physical sciences and engineering). The precalculus course covers five main units. The first unit includes a review of circles, lines, and the quadratic formula; and an introduction to function. The second unit includes transformations of functions both graphically and algebraically, and modeling and using functions in an applied setting. The third unit studies exponential and logarithmic functions, their applications, and solving equations involving these functions. The final two units study trigonometric functions, including right triangle trigonometry, radian measure, the functions' graphs and properties, and various formuli and applications.

Students enrolled in Precalculus at UGA are introduced to WebAssign in their first lecture. They self-enroll into their WebAssign course, and homework awaits them. WebAssign allows for posting of syllabi, worksheets, video, and announcements and also has a gradebook, so there is no reason to use an additional course management system. At UGA there is also a course website that reminds students of the regulations (ID necessary for tests, test format, attendance policy, etc.).

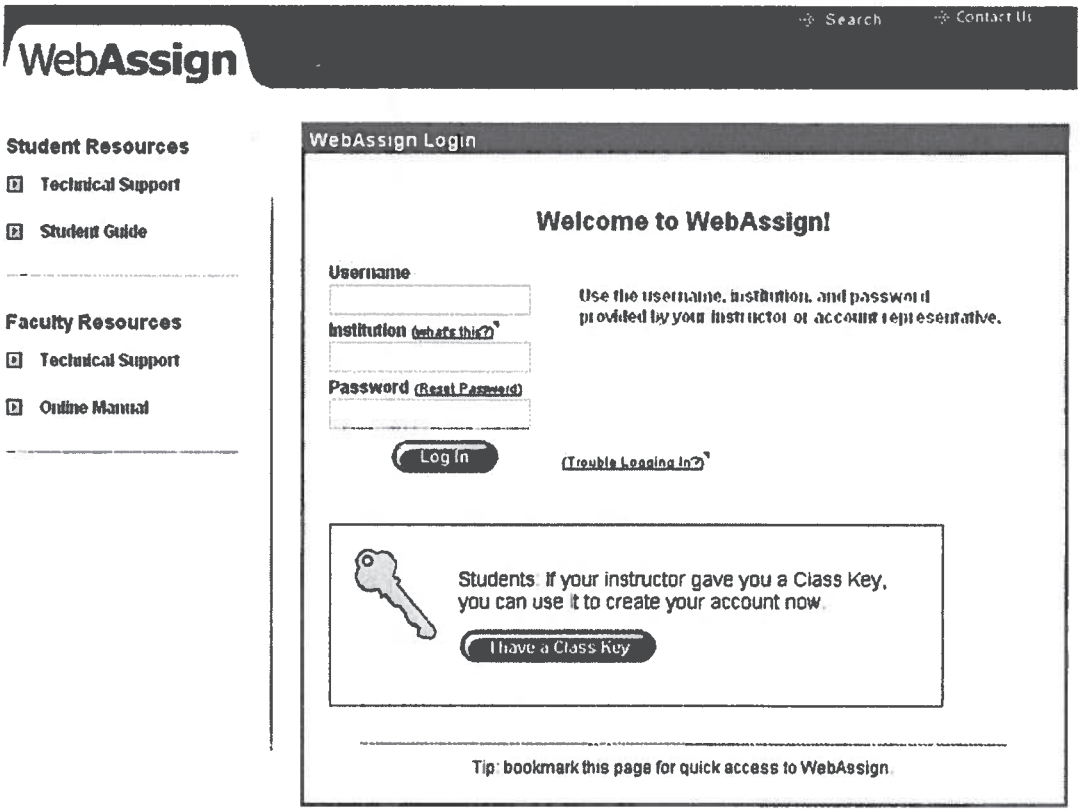

Figure 1: Login page for students and faculty

The course grading is set up so that the instructor is primarily responsible for instruction, with only 10% of the course grade determined by the instructor through in-class assessment activities (such as in-class quizzes). Additional assessment is all provided from within WebAssign. This includes online homework, online webquizzes, and online testing. The testing takes place outside of class, in a proctored environment. Students are partitioned according to sections and may schedule a test time for any one of many blocks on a given test day; the scheduling is completed online as well. Course grades are set according to common gradelines. The uniformity of assessment and gradelines helps ensure that the grade of A symbolizes the same level of calculus-readiness, regardless of class section or instructor.

WebAssign offers databases of questions linked to specific texts from various publishers, and there is also the opportunity to write your own questions or modify those from the coordinating text. Mathematical questions may be numeric answer, multiple choice, or

symbolic format, with a variety of grading rubrics available. For homework, we reveal the key to a problem after one attempt and allow multiple attempts as well as "practice another version" to underscore the message that homework is developmental in nature. In our setup, is possible for a student to earn a 100% score on homework, but whether they work problems to learn or just copy the key is their choice. On the WebQuizzes we allow only three tries per problem, with a penalty for incorrect attempts. The tests are formatted similarly, with only two tries per question. This alleviates some student unhappiness regarding the lack of partial credit. It is understood and encouraged that homework and WebQuizzes can be collaborative in nature. However, both WebQuizzes and Tests feature pooled questions: unlike the uniform homework, each student sees different forms of similar questions, with randomized numbers in all questions.

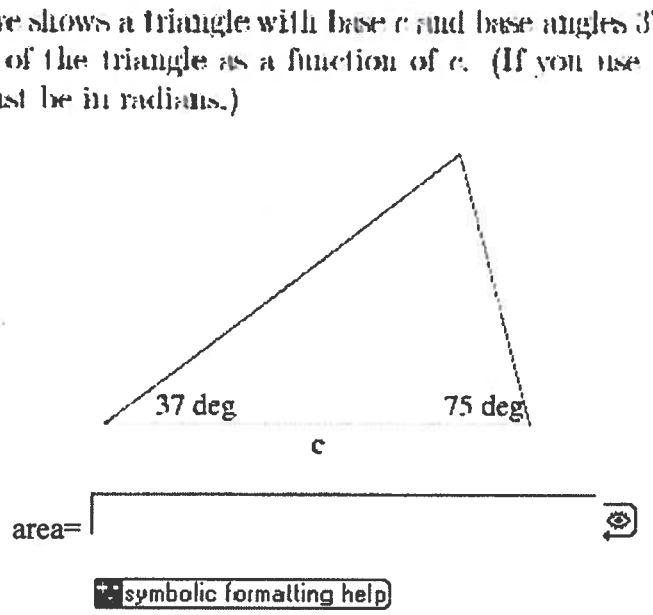

Figure 2: A (homegrown) question from student homework, with randomized numbers.

Student online work presents difficulties unique to mathematics. We prefer symbolic to numeric answers because calculators are very powerful and offer shortcuts that require no mathematical thinking on the part of students. The problem above shows that the student must learn to use correct mathematical syntax, a source of great frustration to students. The symbolic formatting help menu provides information on how to type mathematics correctly, and the previewer (eyeball) allows a student to determine if s/he has typed correctly prior to problem submission. WebAssign plans to debut a mathematical palette which will alleviate some of these difficulties.

At UGA, the course coordinator (this author) sets up the courses for the instructors and also teaches a seminar to mentor the graduate students teaching this course for the first time. I create all the assignments: homework, webquizzes and tests; and publish them with various duedates and IP restrictions to all the sections. We have a library of all

problems in our database of questions available to the instructors, so that they can see the types of problems that their students should have some familiarity with. To ensure that no one section has an unfair advantage, the tests are not revealed to the instructors until the day of their test. Some questions in the database are reserved for tests so that students have to work through new problems using their individual understanding of the content rather than just memorizing techniques for each of the problems in their experience.

The use of WebAssign for online testing at UGA creates some security issues. WebAssign has nice tools to help us overcome these issues. First, the tests are IP-restricted to be opened only on a designated testing computer. There is a timer set for each test so that students get the same amount of time. Then, all other assignments (homework and webquizzes) are IP-restricted *away* from the testing centers, so that a student working on a test cannot retrieve answers from already completed assignments. Finally, WebAssign has restrictive software to keep students from opening other software or browsing the web during tests. At UGA, we haven't yet employed this option but we do have undergraduate student proctors who check ID's at the door and monitor the students during the exam for all kinds of cheating. The proctors and a strong honor code at UGA helps keep the incidences of cheating to a minimum. Rather than use low-level calculators or reset each calculator at the door, each testing PC has a copy of Virtual TI-83 available to students. To use this software legally, the department owns an equal number of TI calculators. Test questions are designed to disallow use of the calculator's solver, since that is not a skill we are developing in preparation for calculus.

Using online assessment has some distinct advantages and disadvantages. The program at UGA establishes greater grade uniformity across sections and prevents students from thinking they can shop around for an easier instructor (they shop around for class times that are convenient instead). Indeed, measures of teaching effectiveness can be made by comparing test averages across sections. Students can work collaboratively outside of class on homework and webquizzes, and they can work together even when registered for different sections. The fixed testing dates and unit content for a given test lead to a rigid schedule and little flexibility to meet student needs, although it is easy to substitute teach for colleagues. The homegrown database of UGA problems to draw from is still small, but has grown significantly in the last 1.5 years. The database needs to be large enough that the tests measure student understanding rather than student ability to memorize lots of problem types.

As we are just starting to use WebAssign at UGA, the final accounting will be a few years down the road. The initial feedback is positive. The faculty appreciate several features of WebAssign, beginning with an easy-to-use gradebook and communication features. They can view details of student work, including when the work was begun and completed, and all responses entered by the student. The instructors are more cognizant than students that the program is only as good as the creator who makes appropriate, timely assignments, and the instructor who guides a student through the nuances of entering mathematics in an online environment. The student feedback is mixed. Of my own course evaluations (anonymous, and also online), there were more complaints about the use of WebAssign to enter mathematics in my first term teaching with the program

than after I had mastered the ins and outs. In subsequent terms, students are still irked about losing points on tests for typing the mathematics incorrectly. Naturally, they don't distinguish that the "typing" mistakes are revealing a fundamental lack of understanding of the order of operations. This past term I had several students willing to tell me in person that they appreciated the online homework for its preparation toward tests and the opportunities to focus on those problems they didn't immediately master. I regularly pointed out the times that the online testing favored their score over a paper test (to whit, choose a graph in multiple choice format online versus being asked to create the given function's graph on paper), and helped them see the advantages that countered the readily perceived disadvantage of no partial credit. From an anonymous course evaluation, I am happy to quote:

"I believe that the online homework and web-quizzes give students another way to understand the material given in class. These materials have substantially improved my grade, and helped me in understanding how to do the new material."

References

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