

## ADMINISTERING AND CUSTOMIZING PREREQUISITE DIAGNOSTIC QUIZZES

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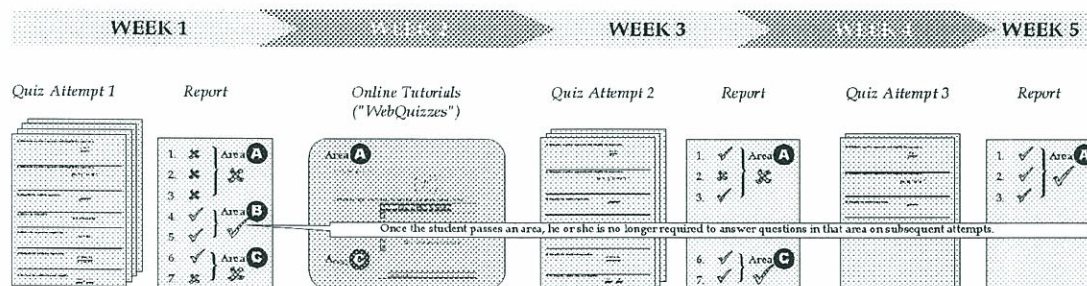
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### *Introduction*

One of the obstacles that prevent many students from succeeding in calculus is their weak algebra and trigonometry background. An ongoing effort to address this problem at Old Dominion University implements a customized diagnostic assessment/tutorial cycle [1]. The cycle begins with a gateway quiz on pre-requisite material. In Calculus I the questions come from the algebra and trigonometry sequence. In Calculus II they are tested on algebra, trigonometry, and Calculus I topics.

From a diagnostic point of view, the material from these courses is categorized into several content areas. For example, exponents, factoring from algebra; trigonometric values, trigonometric identities from trigonometry, and basic derivatives and integrals from Calculus I. To get a passing score in a given area, the student must correctly answer all questions within that area (no partial credit is given). Otherwise, the student is identified as having at least some deficiency in that area, and will be given an opportunity to correct it.

Based on the outcome of the diagnostic quiz, each student is asked to complete a series of online tutorials for all the areas they are deficient in. The tutorials provide the students with extensive guidance to help them reach the goal of attaining 100% correct answers. We allow the students to re-take the portions of the diagnostic quiz they failed on the initial attempt. Each student gets a custom-made version of the quiz, containing only the relevant questions. Passing the second attempt in each area (or the final, third attempt), would restore the lost points to the student.



## Content Areas and Questions

Currently, the question bank we use consists of 24 questions, each of which is available in multiple versions for subsequent attempts or for various semesters. These 24 questions are grouped into the content areas as follows:

Courses	Areas		Questions
Calculus I, II, and III	A	Exponents and Radicals	1, 2, 3
	B	Algebraic Expressions	4, 5
	C	Fractional Expressions	6, 7
	D	Equations and Inequalities	8, 9, 10
	E	Lines and Circles	11, 12
	F	Functions	13, 14, 15
	G	Polynomial Division	16
	H	Logarithmic Functions	17
	I	Trigonometry	18, 19
Calculus II and III only	J	Trigonometric Identities	20, 21
	K	Limits	22
	L	Derivatives	23
	M	Integrals	24

When selecting the questions and the areas, we were guided by the following considerations:

- Questions within the same area should be closely related, so that the mastery of the area requires that all the questions be answered correctly. E.g., questions 1-3 ask the student to simplify expressions such as these:

$$\frac{s^{-4}t^{-1}}{t^{-2}s^2} \quad (3a^{-1}b^2)^{-2}(a^{-4}b)^{-1} \quad \sqrt{16x^2y^{16}}$$

If a student makes a mistake in one of these, we believe it is appropriate to have the student work on the entire area, then retake it (rather than narrowly focusing only on the specific types of questions they missed).

- Tutorial modules ought to be available to help students work on each specific area. In particular, online homework modules made available by textbook publishers tend to have their calculus prerequisite material structured around the tables of contents of their precalculus books.

The mapping of questions to specific areas can be easily customized.

## Offline Quizzes and Online “WebQuiz” Tutorials – Why Not Go 100% Online?

We acknowledge that technology is currently available to administer the entire sequence of quizzes and tutorials completely online. Doing so would have a number of benefits:



- Saves paper;
- Does not require class time or testing center arrangements;
- Saves professors' time - no manual grading required;
- Completely automatic.

The latter two issues merit further discussion.

While some tedious tasks (e.g., grading multiple-choice questions) are best left to the computer, it is not always obvious that the professor should be removed from the loop just because the computer is capable of handling some task. In fact, it can be argued that professor's teaching (pace, choice of examples, etc.) can greatly benefit from knowing the specific types of mistakes that tend to be made by his or her students.

Furthermore, the online mode is "completely automatic" only to the extent this functionality is supported by the specific online homework system we use. Since these systems are mostly proprietary, interoperability tends not to be their strong side. The solution we pursue, while less technologically elegant, allows for added flexibility.

#### *Implementation of the Quiz and Tutorial System*

Our solution requires the following three software components to be implemented:

- Access to an online homework system for faculty and students - either publisher-provided, e.g., ThomsonNow [2], or public domain, e.g. WebWork [3], (our implementation is currently based on ThomsonNow)
- Faculty access to Microsoft Excel (we currently use MS Office 2000) and
- Faculty access to Scientific Workplace (we currently use version 3.51). Note that the extent to which this software is required is limited to converting TeX files to dvi, then printing the latter. A number of public domain software products exist that offer this functionality as well, but we have not tested them.

There are two Excel files used for generating quizzes and reports:

- The individual instructor data file (containing the student scores), and
- The repq.xls file containing the quiz and report templates

When these files are linked, they can be used to generate the quizzes, grading keys, and reports:

	<i>Quiz</i>	<i>Quiz key</i>	<i>Report</i>
<i>Attempt 1</i>	Print1	Print1 Key	Print1R*
<i>Attempt 2</i>	Print2*	Print2 Key	Print2R*
<i>Attempt 3</i>	Print3*	Print3 Key	Print3R*

(\* asterisk indicates custom documents generated for individual students; otherwise the document is generated in one copy only)

All documents being generated within the Excel spreadsheet are in LaTeX format, and need to be further processed. This is described in detail in the instructions contained in a technical report available from the first author [4].

The following customizations can be performed in order to accommodate different courses or institutions:

- The heading of all quizzes and reports, including the instructor's name, section, course, etc., can be edited. Furthermore, the language of the Honor Pledge printed on all quizzes can be altered.
- The assignment of questions into content areas can be easily changed.
- Questions themselves can be replaced or added.

### *Conclusions*

Our project has been piloted for almost two years. While we continue to fine-tune some of the parameters of the Prerequisite Diagnostic Quiz and Tutorial sequence, its success thus far will merit adopting the sequence across all sections of Calculus I and II taught at Old Dominion University starting in Fall 2007.

### REFERENCES

1. Bogacki, P., "Calculus Prerequisite Diagnostic Tests and Tutorials with iLrn", Proceedings of the Eighteenth International Conference on Technology in Collegiate Mathematics, held in March 2006 in Orlando, Florida
2. URL: <http://www.ilrn.com> Accessed on February 14, 2007
3. URL: <http://webwork.rochester.edu/> Accessed on February 14, 2007
4. Bogacki, P., "Step-by-step Instructions for Administering and Customizing Prerequisite Diagnostic Quizzes", Technical Report