# Improving the Quantitative Skills of Introductory Geology Students at a Large Urban Community College

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## Introduction

Students in a physical geology class at Austin Community College used math tutorials from "The Math You Need, When You Need It" (TMYN) project to address deficiencies in quantitative skills. Initial results show that the students not only improved their quantitative skills immediately after completing the tutorials, but also retained those skills throughout the duration of the course. These promising initial results justify the continued use of TMYN.

## The Setting

Austin Community College is an open-door admissions institution whose students show a wide range of mathematical competencies. This poses a serious instructional challenge in the laboratory, where students must perform unit conversions, calculate rates and gradients, and rearrange algebraic equations.

A typical ACC geology student:

- Is a non-science major
- Needs to satisfy a degree requirement for a laboratory science class
- "Math-phobic" or long out of practice
- Believes that geology is not quantitative
- Expects that "geology will be easy"

## What is TMYN?

"The Math You Need, When You Need It" (TMYN) project is a series of web-based quantitative tutorials for math remediation at *http://serc.carleton.edu/mathyouneed/*. The tutorials are written in a geoscience context, and give students math skills immediately before they will use them in a concurrent geoscience course.

## Implementation

TMYN was implemented in a physical geology class, which serves as the introductory freshman-level geology course for geology majors. As part of the core curriculum, it satisfies degree requirements for a science class with a laboratory.

The goals for this implementation of TMYN included:

- improve overall student success in the class
- improve student confidence with basic math skills
- reduce instructional time spent teaching basic math skills
- increase time spent on interpretation of results

TMYN tutorials used in this course were chosen to specifically address areas tht students often have difficulty with during the laboratory part of this course, such as rearranging equations (Figure1).

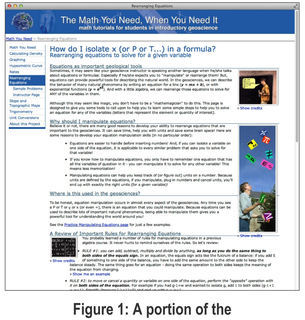


**Figure 1: A portion of the Rearranging Equations tutorial.**

TMYN tutorials were assigned as asynchronous pre-lab assignments (Table 1) to be completed before the associated laboratory assignments.

| Tutorial | Laboratory Exercise Topic |
|---|---|
| Unit Conversions | Plate tectonics |
| | Topographic maps |
| Rearranging Equations | Plate tectonics |
| | Absolute dating |
| | Earthquakes |
| Rates | Plate tectonics |
| | Fluvial systems |
| Slopes | Topographic maps |
| | Streams |

**Table 1: Tutorails used in this class, and the topics covered.**

Students took a mastery quiz upon completion of each tutorial (Figure 2).


**Figure 2: A typical mastery quiz question.**

Each quiz counted toward the student's final grade, and consisted of three questions that applied the math skills in a context similar to what the student would see on the upcoming lab exercise.

Because the goal was for students to master concepts, they were allowed as many attempts as necessary to get the correct answer for each question, and were not penalized for multiple attempts.

## Impact of TMYN on Students

Key results include:

- **Students demonstrated improved preparedness for the laboratory assignments.** Students were able to complete the quantitative exercises with less direction and assistance from the instructor.
- **Students outperformed students from previous semesters.** Student scores increased by an average of 10 points on the laboratory quiz with the greatest quantitative content.
- **Multiple assessments indicated that students retained their math skills for the duration of the class.** This may translate to improved performance in other courses as well.
- **Anecdotal student feedback was overwhelmingly positive.**

At the conclusion of each mastery quiz, students rated the utility and difficulty of each tutorial in preparing them for their laboratory exercise (Table 2).

| Course and semester (total enrollment) | Modules used (in sequential order) | Number of students who completed module | Completion rate | Percentage of students responding with "agree" or "strongly agree" to questions about: Helpfulness | n | Difficulty | n | Average module score |
|---|---|---|---|---|---|---|---|---|
| Physical Geology, Fall 2011 (n=22) | Rates | 20 | 91% | 79% | 19 | 40% | 20 | 93% |
| | Rearranging equations | 19 | 86% | 88% | 16 | 24% | 17 | 93% |
| | Unit Conversion (general) | 19 | 86% | 84% | 19 | 50% | 18 | 87% |
| | Topographic Maps | 16 | 73% | 60% | 15 | 64% | 14 | 83% |
| | Unit Conversion (maps) | 16 | 73% | 77% | 13 | 67% | 12 | 73% |
| | Rates/Rearranging Equations | 15 | 68% | 73% | 15 | 7% | 15 | 100% |
| | Pretest | NA | | | | | | NA |
| | Posttest | NA | | | | | | NA |

**Table 2: Student rankings of utility and difficulty of each tutorial.**

The majority of students found all of the assigned tutorials to be helpful, even if the tutorials were difficult. Interestingly, the tutorial that the students found the most difficult was also the one students found to be the most helpful.

## Impact of TMYN on Course Content

Improved student mathematics skills translated into less instructional time spent discussing the mathematics, and more instructional time interpreting the results.

It is clear that when TMYN is fully integrated into this physical geology curriculum, additional quantitative content can be added to the laboratory assignments without negatively impacting the instructor's in-class instructional time.

## Recommendations for Implementation

Before implementing TMYN, carefully consider these areas and tailor your approach to TMYN to best serve you and your students' needs:

- Characteristics of your student population
- Topics to which math will be applied
- Number of tutorials to be used
- When each tutorial should be introduced
- Proximity of practice to application
- Grading stakes

Also carefully consider how best to implement TMYN in your class. Some approaches include:

- *Optional* for all students
- *Optional* for students who demonstrate poor math skills
- *Required* for students who demonstrate poor math skills
- *Required* for all students as part of lab exercises
- *Required* for all students as pre-lab exercises

## Implementation Challenges

While implementation of TMYN is straightforward, there are a few pitfalls to avoid.

- **Help students get started.** Some students are uncomfortable with technology, but showing them the website during class may remove some of their initial fear. Together, review how the tutorials are organized and how the dropdown arrows work.
- **Anticipate computer needs.** Some students do not have computers or Internet access at home; provide your class with the locations of computers available on campus.
- **Anticipate technical glitches.** Encourage the students to try again if the website is temporarily down.
- **Keep TMYN in the minds of the students.** If the tutorial due dates are scattered throughout the semester, give the students occasional reminders of upcoming due dates.

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