THE MATH YOU NEED, WHEN YOU NEED IT

Web-Based Modules to Help Students Succeed in Introductory Geoscience Courses

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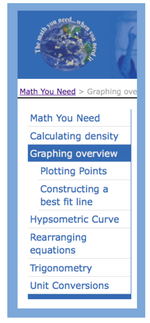
ABSTRACT

Based on results of a pilot project and a faculty survey, we present several pedagogic modifications to the NSF-funded, NAGT-sponsored The Math You Need, When You Need It (TMYN) project. TMYN is a series of web-based student modules designed to provide self-paced supplemental instruction for learning of quantitative skills necessary for success in introductory geoscience courses. Each module includes instructions, solved sample problems, an assessment administered online or on paper, and an instructor's page. In addition, students take pre- and post-tests to determine which modules they need to complete.

Modifications to modules and assessments, such as pre- and post-tests and graded quizzes, were made based on the piloting of a one-credit co-requisite online course that paralleled Geology 101 at Highline Community College. Initial assessment of the modules used in conjunction with a geoscience course suggests that some students continue to need close supervision and face-to-face support. Student comments emphasize the need for transparency about the purpose of completing the modules and thorough integration between course content and modules. We introduce several new modules designed to make integration easier by providing multiple opportunities for both faculty and students to use quantitative skills in the context of geology. Because this project should be useful to a significant number of educators, new module topics were based on results of a worldwide survey in which faculty were asked to select topics most relevant to their course(s). Faculty have a variety of options for implementing these modules as a part of a geoscience course, from using one module to integrating all modules into a single course or offering a shadow online course. We will share several ideas about options for using these modules and ways to adapt them to fit your course and your students.

AVAILABLE MODULES



What is THE MATH YOU NEED?

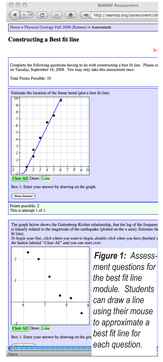


Figure 1: *Assessment questions for the best fit line module. Students can draw a line using their mouse to approximate a best fit line for each question.*

We designed The Math You Need, When You Need It (TMYN) modules for use in any introductory geoscience course. Modules cover quantitative topics that are introduced in introductory geoscience courses and give examples based in a broad range of geoscience topics. Our goal is to increase students' comfort and familiarity with mathematics and its application to real world problems.

Each module is self-contained and can be incorporated into an introductory geoscience course at any appropriate point during the semester. Students should work through the module just before they need to use it in the course. Each module has 3 student portions and one instructor page. The first student page includes an introduction and explanation of mathematical/quantitative topic as well as supplemental resources and examples of applications in many geoscience topics. The second has several sample problems with worked solutions. The third is a web-based assessment of the skills learned that automatically assigns a grade based on parameters set by the instructor. Instructors can also add their own questions to the assessment. The instructor page includes what the student will learn, other information about teaching the given quantitative topic, as well as teaching resources.

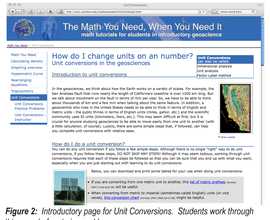


Figure 2: *Introductory page for Unit Conversions. Students work through this page before trying problems.*

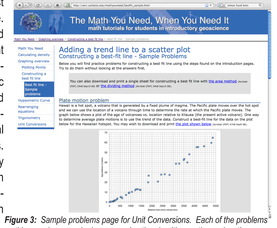


Figure 3: *Sample problems page for Unit Conversions. Each of the problems on this page has a worked answer using the algorithm on the explanation page.*

PILOT LOCATIONS

Highline Community College

Institutional statistics

- 2-year public college in suburban Seattle (Des Moines, WA)
- Associate's degrees; 40 certificate programs
- 92% local students from King County, WA (92%)
- 16,000 students (4500 FTE, 46% full-time)
- 52% non-white, 2% international, 59% female
- 50% work, 29% in basic skills programs (e.g. ESL, GED)
- 63% of entering students plan to transfer to 4-year school
- 53% of students receive Associate's degree
- 140 tenure/tenure-track faculty, ~400 adjunct faculty; student-faculty ratio: 30:1

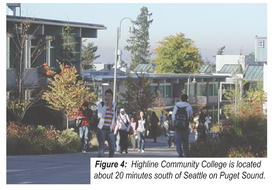


Figure 4: *Highline Community College is located about 20 minutes south of Seattle on Puget Sound.*

Figure 5: *Highline's geology courses are limited to 24-28 students each quarter.*

Geology program

- In the Physical Sciences department
- 1 tenured faculty, one non-tenured full time faculty
- Typically 5-10 students declare interest in a Bachelor's degree in geology

Introductory geoscience courses

- Five introductory level courses: Physical Geology, Environmental Geology, Geo-Hazards, Geomorphology, Pacific Northwest Geology
- 24-28 students per class
- All satisfy general education requirements for Associate's degree
- Labs and lectures are taught by the same faculty member

University of Wisconsin Oshkosh

Figure 6: *University of Wisconsin Oshkosh is located in east-central Wisconsin (Oshkosh, WI) and has a large residential population. Pictured is one of the first-year dormitories.*

Institutional statistics

- 4-year comprehensive public university in a town of 60,000 (Oshkosh, WI)
- Associate's and Bachelor's degrees (45 programs)
- 97% of students from Wisconsin
- 11,000 undergraduates (10,000 FTE)
  - 6% non-white, 0.6% international, 59% female
- 1st to 2nd year retention rate 76.2%
- 6-year graduation rate: 53.2%
- 300 faculty, 268 instructional academic staff, student-faculty ratio: 21:1

Geology department

- In the College of Letters and Science
- 7 tenured faculty members, 2 academic staff
- Four possible majors (Professional Geology or Hydrogeology, Liberal Arts, and Earth Sci. Ed.)

Introductory geoscience courses

- Two entry-level geoscience courses: Physical Geology and Environmental Geology
- 144-192 students in each of 5 lecture sections per year
- Both satisfy general education requirement for a Bachelor's degree
- 6-8 lab sections of 24 students associated with each lecture section
- Lecture sections may be taught by up to 5 different faculty per year
- Lab section may be taught by any member of the teaching faculty

Figure 7: *UW Oshkosh's geology courses are taught in "pit" classrooms and serve approximately 850 students per year (5 sections, ~170 students per section).*

http://serc.carleton.edu/mathyouneed

PILOTS

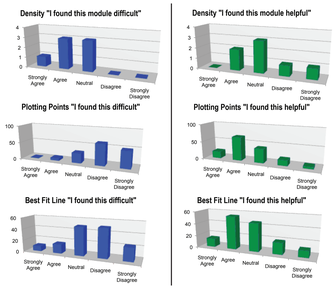
Highline (Spring 2008)

Students enrolled in Geology 101 were required to take a one credit course (Quantitative Geology) if they did not pass a skills assessment. 9 of 24 students did not achieve this level and were required to take the course which included several quantitative skills and one module developed for this project (Density). Other parts of the course mimicked the arrangement of TMYN modules but were much more rudimentary and housed at Highline.

Oshkosh (Fall 2008)

Students enrolled in Geology 102 (Physical Geology) were required to complete three modules (Unit Conversions, Plotting Points and Best-fit line) before the topics were covered in a lab. They were also given a written pre-test that covered 5 mathematics topics that would be covered in the lab.

RESULTS



Student Response to Modules

Immediately after completing the assessment, students were asked to respond to two statements: "I found this module difficult" and "I found this module helpful". Students responded according to their agreement with this statement using a 5 point scale (strongly agree to strongly disagree). At Highline, students responded to these statements for the density module; Oshkosh students scaled the statements in response to two graphing pages. In general, students responded positively to the statement about helpfulness but Oshkosh students find graphing less difficult than Highline students found density.

Students at Highline were also asked several questions about learning outcomes in the online mathematics course. Responses were positive overall in relation to instructions and alignment with the geology course but students were more negative when it came to their impressions about mathematics in geology.

Student assessment of modules	Strongly Agree	Agree Somewhat	Disagree Somewhat	Strongly Disagree
The instructions for completing the online assessments were clear and understandable	3 (37.5%)	3 (37.5%)	2 (25%)	
The instructions for completing the online modules were clear and understandable	2 (25%)	2 (25%)	3 (37.5%)*	
The online assessments closely related to the material covered in the online modules	5 (62.5%)	2 (25%)	1 (12.5%)	
I tried to complete the modules by the due dates.	2 (25%)	4 (50%)	2 (25%)	
There was clear and timely alignment between the topics in the Geology 189 modules and what my instructor, covered in class	3 (37.5%)	4 (50%)	1 (12.5%)	
Taking Geology 189 helped me do better in Geology 101.	1 (12.5%)	1 (12.5%)	4 (50%)	2 (25%)
In Geology 101, we use a lot of mathematical skills.	1 (12.5%)	3 (37.5%)	3 (37.5%)	1 (12.5%)

Table 1: A survey of the students in the one credit course at Highline (Geology 189) received 8 responses (89% response rate).

Skills Improvement (Oshkosh)

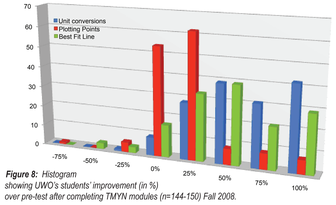


Figure 8: *Histogram showing UWO's students' improvement (in %) over pre-test after completing TMYN modules (n=144-150) Fall 2008.*

Results indicate that quantitative skills improvement at UW Oshkosh were mixed. Students showed improved performance from pre to post-test after completing the Best-fit Line and Unit Conversions with students either improving or maintaining their scores. On the other hand, 40% of students who completed the Plotting Points module scored lower after working through the module. This may stem from the fact that the computer is more precise than the instructor at grading points plotted. Additionally, students may have had difficulty accurately plotting points (see *Lessons Learned*).

Figure 9: *Instructor of Physical Geology lecturing to her large lecture section.*

Faculty Response

- Need greater communication among instructors of math course (Geo 189) and introductory geology course when one is not teaching the other
- Students had difficulty using more than one site for modules at Highline
- Impact of modules on quantitative skills was unclear at Highline.
- Positively impacted ability to cover quantitative concepts in the course (Oshkosh)
- Students expressed appreciation for the review in the course at Oshkosh
- Some students still need a lot of "hand-holding" about use of the resource.

Lessons Learned

- Students must be prodded to complete the modules (Highline)
- Students still need some support in face-to-face situations or via e-mail (Oshkosh)
- Engagement in the modules is difficult to achieve (Highline)
- Students do not see geology as using many mathematical skills (Highline)
- Some students see transfer to other parts of geology (from conversation, Oshkosh)
- Mechanics of graphing assessment needs work (setting reasonable parameters).
- The WAMAP software is more powerful for mathematics testing than other course management systems

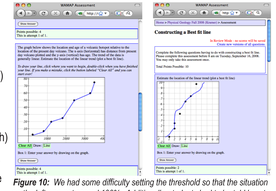


Figure 10: *We had some difficulty setting the threshold so that the situation on the left was not scored 100%. Additionally, students had to be told how to click the mouse so that theirs didn't end up totally inaccurate (right).*

WOULD YOU LIKE TO USE TMYN WITH YOUR COURSE?

If so, please drop your card below or use one of our questionnaires. If you use your business card, please include the title of your class and which modules you think would be useful to you on the back of the card. ***THANK YOU!!***