What is COMPUTATIONAL GEOLOGY?

A companion to "Alumni Narratives on Computational Geology (Spring 1997 – Fall 2013)"

Introduction

Computational Geology is a geology course at the University of South Florida. It is offered to upper-level undergraduates in the School of Geosciences. Currently it is an elective; about half the geology majors take it, and the vast majority of the students who take the course are geology majors. The course number has varied over the years but, with the new catalog in about a year, will be GLY 3866, indicating a third-year class. Class sizes usually run up to about thirty students. The class has been taught yearly by H.L. (Len) Vacher; when the offering was expanded in 2016 to twice-yearly, the second class section was taught by Charles B. (Chuck) Connor. Both instructors who have taught the course (Vacher and Connor) are senior professors with a long history of in-discipline research.

The focus of the course has always been geological-mathematical problem solving (Vacher 2000). That is, the course features *problems* – geology-contextualized scenarios (word problems) that require the use of reasoning and quantitative skills to solve – rather than *exercises* (repeated-practice end-of-chapter-style "problems" performed right after a particular skill is taught). The course aims to improve student comfort with numeracy (numbers, equations, and calculations), quantitative literacy (verbal and graphic communication), and quantitative reasoning (critical thinking habits of mind).

The background prerequisites and in-course topics are consistent with the goal of promoting numeracy, quantitative literacy, and quantitative reasoning. The only prerequisite is calculus 1, although the course at its current evolutionary state does not require students to perform much calculus, if any. Successful completion of calculus is required to assure a certain level of exposure and mathematics maturity (if not understanding), but, in the course, calculus is discussed in a largely conceptual manner with the purpose of contextualizing, clarifying, and consolidating students' prior experiences (as opposed to sharpening or adding calculus skills per se). This recognition that there is more to relevant math than just calculus contrasts with the original (1996) incarnation of the class, where calculus was heavily featured in a syllabus that was determined based on what students identified as problem areas for themselves.

In fact, during the thesis study "Alumni Narratives on Computational Geology (Spring 1997 – Fall 2013)" (Ricchezza 2016), respondents indicated that the makeup of the course topics changed significantly over the 16 year span of when they took the course. This change has continued since the last of the interviewees finished the class in fall of 2013, with significant changes in fall 2015 to incorporate aspects of cognitive load theory (Sweller 1988). Principal among these is a doubling-down on word problems. Now students are required to write, submit, and be graded on word problems of their own, by means of a course-management system discussion board in which they critique the problems proffered by each other. We are especially enthusiastic of this new feature of the class as we see it activating all three aims of the course at the same time: quantitative reasoning, verbal communication, and calculation.

The weekly topics from the fall 2015 course section included:

- QL for everyone
    - numbers and number sense

    - quantities and units
    - proportions and percentages
    - estimation and errors
    - sums and averages
- QL for STEM
    - ratios and rates
    - logarithms and logarithmic scales
    - circles and angles (including basic trigonometry)
    - modeling functions (linear, logarithmic, exponential, and power functions, and how to express and interpret them graphically)
    - direction and distance (vectors)

What's in a name?

Why the name "computational" rather than "quantitative literacy in geology"? In practice, this answer is too convoluted to explain in a simple sentence or two, as the course didn't arrive where it is overnight. But the name has stayed where it is for a good reason: this class heavily uses computers to solve problems.

The course, from the start, has used spreadsheet programs (generally Microsoft Excel) as a problem solving tool. In the fall of 2002, a new tool was introduced to help students with their spreadsheet work – the guidance module. These modules are self-contained PowerPoint presentations that include background information, practice calculations, and information and directions on how to set up a spreadsheet to perform calculations. The modules then ask students a series of questions requiring them to perform similar calculations with data sets that are generally larger than what one would work with by hand (these sets and a worksheet are usually included). These modules became part of a multi-disciplinary project called Spreadsheets Across the Curriculum (Vacher and Lardner 2010), and were instrumental in three NSF grants that were awarded to LV for development of these modules. The modules are still in use and can be found on the Science Education Resource Center (SERC)[1] free of charge.

Where can I get more information?

Vic's personal page, with thesis data and text coming soon, publications, etc.:
http://vicricchezza.weebly.com/thesis.html

References Cited

Ricchezza, Victor J. 2016. "Alumni Narratives on Computational Geology (Spring 1997 – Fall 2013)."

Sweller, John. 1988. "Cognitive Load During Problem Solving: Effects on Learning." *Cognitive Science* 12 (2):257-285. doi: 10.1207/s15516709cog1202_4.

Vacher, HL. 2000. "A course in geological-mathematical problem solving." *Journal of Geoscience Education* 48 (4):478-481.

Vacher, HL, and Emily Lardner. 2010. "Spreadsheets across the curriculum, 1: The idea and the resource." *Numeracy* 3 (2):6.

[1] SSAC at SERC http://serc.carleton.edu/sp/ssac_home/index.html