Vision - Potential

Vision Within Every Instructor - Potential Within Every Student

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[1] Notes on Problem Solving, CUPM Curriculum Guide 2004

(The following is copied from the CUPM Curriculum Guide, 2004, p. 15. The entire Guide is available on-line at www.maa.org/saum/.)

Develop persistence and skill in exploration, conjecture, and generalization. Problem solving requires more than just solid mathematical reasoning—there are broad strategies and mental attitudes that students must identify, master, and internalize. To be successful problem solvers, students must learn persistence in the face of repeated

* Supported by the U.S. Military Academy.

rebuffs and flexibility in the choice of solution strategies. They must replace the question "Did I get the correct answer? with the question "Does my answer make sense?" Students must also learn to explore examples and special cases, to let new knowledge lead to new questions, to generalize and pose conjectures, yet to test all conjectures and retain a healthy skepticism toward unproven claims.

Instructors can stimulate students to generate questions and comments in response to readings, exercises, and presentations by modeling good questioning behavior. What do the words mean? What are some nontrivial examples? What motivates the material? What assumptions are being made? How do I know this is right? Through careful choice of problems and dialogue with students, faculty can also lead students to develop a more skeptical stance toward assertions: Does this make sense? Have all assumptions been enunciated?

Students need to be exposed to multi-stage projects that are built on exploration and conjecture and require persistence and flexibility for their solutions. More generally, at least some courses should be restructured to shift the burden from instructor to students for discovering and justifying results. A mathematical modeling course is an especially apt setting in which to make this shift and to raise students' awareness of the need to state problems carefully, articulate assumptions, and apply the mental and strategic tools of problem solving. Indeed the value of modeling lies at least as much in the artful and creative thinking and thoughtful interpretation that it requires as in the connections it makes between mathematics and other disciplines.

[2] Book Review: *Contemporary College Algebra: Data, Functions, Modeling*

Written by Chris Arney, Vice President
The College of Saint Rose, Albany, NY

(This review appeared in *Mathematics and Computer Education*, vol 38, no. 1, Winter 2004)

I consider teaching and learning college algebra big challenges for the teacher and student, and last semester, I decided to try a reformed approach to the subject. I used Don Small's textbook, which has as its philosophy to educate students for the future. The textbook tries to help students become exploratory learners by having them perform queries (just-in-time explorations included within the text's chapters) and projects (data-driven applications within the text's exercises). I chose this book because I liked Small's list of goals, including improving communication skills, developing teamwork skills, enhancing technology skills, empowering modeling, and building confidence. I think the text helped my students in all these areas.

Don Small is a master at presenting fun and challenging problems. He has included applied problems in sections called "Fun Projects," which require student teams to research, model, solve, and write. Most of these problems start with data that the students are required to turn into useful information.

The book's content is divided into three chapters — data and variables, functions, and modeling. Small encourages the use of technology (mostly a graphing calculator) to help students solve messy problems and the use of graphical analysis in their problem-solving and analysis. These technology skills were a challenge for my students and for me, but once we became used to our calculators and their capabilities, we made real progress on these skills.

In case you think this book is much different from others with the "College Algebra" title, I will list some of the algebraic and arithmetic skills it contains. Some of the classic techniques covered are: percentage, fractions, radian measure, inequalities, graphing, transformations, function evaluations, factoring, iteration, polynomials, logarithmic and exponential functions, trigonometric functions, parametric functions, and logistic functions.

Having used this textbook, I would say that college algebra continues to be challenging. However, I believe that Small's text helped my students achieve some of the book's goals and gave them a taste of exploratory learning, inquiry, and modeling. I recommend trying this book.

[3] Bald Eagle Project

The bald eagle, our national bird, is the only eagle native to North America. The population of eagles, estimated to be as large as half a million when European settlers began to arrive, steadily decreased reaching a low of several hundred pairs in the 1930s. The effects of the Bald Eagle Act of 1940 to provide protection, were compromised by the rapid growth of the use of DDT in agriculture. This chemical greatly reduced the birth rate as it weakened the shells of the eagle eggs making them unable to withstand incubation. In 1967, the bald eagle was declared an endangered species and five years later DDT was banned for use as a pesticide. This marked a turn around in the growth of the eagle population as indicated by the following chart. (Source: U.S. Fish and Wildlife Service.) In 1995, the bald eagle was elevated from the "Endangered Species" category to the "Threatened" category.

Year	# Pairs of Bald Eagles
1986	1875
1988	2475
1990	3035
1992	3749
1994	4449
1996	5094
1998	5748

The following questions can be used to develop a bald eagle project.

a. Form a scatter plot of the data and then using two points, fit a linear curve to the scatter plot.

b. Use a calculator or computer to determine a linear regression equation.

c. Compare the results from parts a and b. If they are different, explain what caused the difference.

d. Interpret the meaning of the slope in the equation in either part a or part b.

e. Use the regression equation to predict the number of eagle pairs in 2000 and in 2002.

f. Research the official population figures for bald eagles for 2000 and 2002. Compare the results with your predictions in part e. Comment on any differences between your predictions and the official figures.

[4] Measuring for a Roof

(This real-life exercise is an example of the use of college algebra in the workplace.)

Bob called the other night asking for help in determining the measurements for a roof that he is building over his portable sawmill. The roof trusses are triangular with a base of 27.5 feet and the two slanted sides have equal lengths (isosceles triangle). The roof's elevation angle is 30 degrees. Bob wanted to know the height and slant length of the trusses. Can you help out?

An interesting follow on question is how many bundles of three-in-one asphalt shingles will be needed to shingle the roof given that the roof is 13 feet long and a bundle of shingles covers $\frac{100}{3}$ square feet?

[5] G-force and NASCAR Drivers

G-force is the gravitational force exerted on a body; one 'G' is equal to the Earth's gravity. G_force is modeled by the following function of three variables: $G(g, r, v) = \frac{v^2}{g*r}$, where g is the acceleration due to gravity 32 ft/sec^2, r is the turning radius, and v is the velocity (ft/sec) of a moving object. Turns at the Daytona International Speedway have a radius of 1000 feet (www.daytona500.com/track) and most NASCAR drivers can stand a force of 5-7 Gs before they pass out. Consider a car that enters a corner at $t = 0$ seconds, traveling with a velocity modeled by: $v(t) = -t^2 + 5t + 177$.

a. At what time is the maximum velocity achieved by the driver?

b. What is the maximum velocity achieved by the driver?

c. What is the maximum G_force experienced by the driver?

[6] Test Questions

a. Create a scenario that can be modeled with a decreasing function that is never zero and then sketch the function.

b. Create a scenario that can be modeled with a periodic function and then sketch the function.

c. Dianna opened an ice cream shop in her house one block from the main street of a small town. Sketch a graph showing her sales from April through August. Explain your reasoning in drawing the graph in the shape that you did.

d. Determine a quadratic equation whose graph contains the points: (0,5), (2,0), (4,3).

[7] Dissemination Workshop

A three day Dissemination Workshop for the Contemporary College Algebra program

will be held May 26-28, 2004 at Miami-Dade College, Miami, FL. Norma Agras (nagras@mdc.edu) is the organizer. Paul Dirks, Elizabeth Succo, Pavlov Rameau, Alvio Dominques, Alex Fluellen, and Don Small will serve as facilitators. Activities will feature:

(a) Hands-on, small group activities and projects
(b) Use of graphing calculators in teaching and learning college algebra
(c) Problem solving in the modeling sense
(d) Modeling using recursive sequences
(e) Elementary data analysis

Several discussions are planned for the workshop. A sampling of topics include the role of college algebra in a student's academic program; formulation of goals for a college algebra course; the national movement to refocus college algebra, and the use of technology.

[8] Notices

1. Correction and Clarification to the article "A BIG Prime Number" in the January 2004 Newsletter, **thanks to Professor Firooz Khosraviyani**.

   Prime numbers are positive integers greater than one whose only positive integer divisors are themselves and one.

   Sieve of Eratosthenes: List the positive integers greater than one in their natural order. Starting with the first number in the list and working through the list, eliminate all nontrivial multiples of each prime. The remaining numbers are prime.

2. Deadline for contributions to the September Newsletter is Monday, September 6, 2004. Opinion articles, suggestions for writing assignments, small group in-class activities, small group out-of-class projects, Queries, announcements, etc. are welcomed.

3. To subscribe to this Newsletter, write to Don Small, Department of Mathematics, U.S. Military Academy, West Point, NY 10996 or contact him via e-mail at don-small@usma.edu.