Vision - Potential

Vision Within Every Instructor - Potential Within Every Student

Newsletter of the HBCU College Algebra Reform Consortium*
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[1] Developmental Mathematics (Part 1)

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There is a great deal of research emerging in the area of developmental mathematics. Many educational researchers are trying to prove what constitutes a "best practice" in relation to developmental mathematics students, programs, and assessment. I, like many post-secondary educators, have found myself in the midst of what seems to be a major crisis. We are regularly graduating more and more students from U.S. high schools with minimal preparation for post - secondary work. Students are entering post - secondary education and withdrawing/dropping out of undergraduate school altogether simply because they cannot pass developmental coursework. The Missouri K-16 Coalition reported to the Missouri Coordinating Board of Higher Education that in 1996 26% of Missouri high school graduates attending public universities in Missouri were enrolled in remedial coursework. Of that number 71.4% were enrolled in developmental mathematics (Missouri State Coordinating Board of Higher Education, 1999). Sheila Tobias was cited from a speech to the National Association of Developmental Education (NADE) as saying one reason students fail is the desire of teachers to teach what and how they were taught (Armington, 2003).

The National Center for Educational Statistics (NCES) (2004) and the National Center for Public Policy and Higher Education (2007) report current data trends that show there is an increase not only in the number of students attending college, but also in the number of students entering unprepared. The suggestions for how to approach this problem is as varied as the student population. NADE (2004), in its Best Practices in Developmental Mathematics, summarized other educational papers and reports from practitioners suggesting a need for change in the way that mathematics is taught – Wiggs (2001) and Hacek (2001) supported changing the environment of the classroom; Clark (2001) and Moon (2001) suggested changes in program delivery. Also, McClory (2001) and Armington (2001) suggested changing placement requirements; Hall (2001), Hughes (2001), Rose (2001), Ahlering (2000), Kinney (2001), & Lacefield suggested changing teaching techniques and methodologies, and Brown (2001) suggested changing the academic support. More recent studies have suggested the above suggestions all stem in some part from our view of students as deficient and in need of fixing (Krovetz, 1999; Henderson, Benard,

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and Sharp-Light, 2007). Henderson et. al. and Krovetz all agree that educators should consider viewing at-risk students from a resiliency perspective rather than a deficiency perspective.

Resiliency can be defined as the ability to overcome adversity. Resiliency theory as it relates to education is based on the belief that all students can learn and have the abilities to do so if the proper factors are in place. This is not to say that life circumstances can be avoided. Educators cannot control what happens to students 24/7. However, the resiliency model suggests to students and teachers alike that their success or failure is not based on life circumstances as much as learning how to overcome adversity (WestEd, 2010).

Now, how does resiliency relate to redesigning courses? A portion of resiliency and youth development is designing programs that include school, family, peers, and the community where each hold the student accountable by showing they care, they have set high expectations, and that they will be provided with activities that are meaningful. It is with this in mind that I considered my courses for the new semester. How can I include the community, family, peers, and the university in each lesson? After attending a workshop at West Point in New York, I eagerly revisited my final exam to make sure it was in line with the goals of NADE. What was I really trying to teach? What did I really want my students to know? What does a grade of A in this class really mean? These are the questions with which I began my redesign. I realized that many of my semester exams were in no way similar to the final exam. My homework did not always introduce nor review concepts that were on the exams. It was as if I was teaching and testing something totally different.

(Donna will present her goals and objectives in Part 2 of this paper that will appear in the November issue of this Newsletter.)

[2] What the Partner Disciplines Want from College Algebra (Part 2)

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In the last issue, the author discussed some background on the status of College Algebra – the fact that over 1,000,000 students take these courses each year, that they have abysmally low success rates, why students take them (to fulfill requirements from other disciplines), and how it is the wrong course for the overwhelming majority of the students.

Since the main reason students take the course is to satisfy requirements of other disciplines, it is important to know what those disciplines want their students to get from mathematics. To find out, the MAA's committee on Curriculum Renewal Across the First Two Years (CRAFTY) conducted its Curriculum Foundations project. Leading educators from 25 fields participated in discipline-workshops where they discussed the current mathematical needs of their field and developed recommendations to the mathematics community. The recommendations from the first round of 17 Curriculum Foundations workshops are in [1]; the remainder will appear soon.

Consider the following comments made by the biologists, whose students account for the largest number of students from the laboratory sciences in our courses.

- The collection and analysis of data that is central to biology inevitably leads to the use of mathematics.
- Mathematics provides a language for the development and expression of biological concepts and theories. It allows biologists to summarize data, to describe it in logical

terms, to draw inferences, and to make predictions.
• Statistics, modeling and graphical representation should take priority over calculus.
• The teaching of mathematics and statistics should use motivating examples that draw on problems or data taken from biology.

The most important quantitative skills needed for biology are:
• The meaning and use of variables, parameters, functions, and relations.
• To formulate linear, exponential, and logarithmic functions from data or from general principles.
• To understand the periodic nature of the sine and cosine functions.
• The graphical representation of data in a variety of formats – histograms, scatterplots, log-log graphs (for power functions), and semi-log graphs (for exponential and log functions).
• Some calculus for calculating areas and average values, rates of change, optimization, and gradients for understanding contour maps.
• Statistics–descriptive statistics, regression analysis, multivariate analysis, probability distributions, simulations, significance and error analysis.

Finally, the biologists make some interesting observations regarding the relationships between mathematics and biology, including
• The sciences are increasingly seeing students who are quantitatively ill-prepared.
• The current mathematics curriculum for biology majors does not provide biology students with appropriate quantitative skills.

Next consider the physicists, who one might expect to demand the most mathematics of their students. Their main points were:
• Conceptual understanding of basic mathematical principles is very important for success in introductory physics. It is more important than esoteric computational skill. However, basic computational skill is crucial.
• Development of problem solving skills is a critical aspect of a mathematics education.
• Courses should cover fewer topics and place increased emphasis on increasing the confidence and competence that students have with the most fundamental topics.
• The learning of physics depends less directly than one might think on previous learning in mathematics. We just want students who can think. The ability to actively think is the most important thing students need to get from mathematics education.
• Students need conceptual understanding first, and some comfort in using basic skills; then a deeper approach and more sophisticated skills become meaningful. Computational skill without theoretical understanding is shallow.

Finally, consider the major points from business faculty:
•Mathematics is an integral component of the business school curriculum. Mathematics Departments can help by stressing conceptual understanding of quantitative reasoning and enhancing critical thinking skills. Business students must be able not only to apply appropriate abstract models to specific problems but also to become familiar and comfortable with the language of and the application of mathematical reasoning. Business students need to understand that many quantitative problems are more likely to deal with ambiguities than with certainty. In the spirit that less is more, coverage is less critical than comprehension and application.
• Courses should stress problem solving, with the incumbent recognition of ambiguities.
• Courses should stress conceptual understanding (motivating the math with the "whys" – not just the "hows").
• Courses should stress critical thinking.
• Courses should emphasize statistical think-

ing to reflect the uncertainties and risks associated with business decisions.

When one discusses these issues in depth with faculty from the lab sciences to see precisely what they mean, some fascinating perspectives become evident. In biology, and to a somewhat lesser extent in chemistry and introductory physics (especially in large offerings such as earth and space science), extremely little mathematics arises in the classroom. Mathematics arises almost exclusively in the laboratory, when the students have to interpret and analyze their experimental data, and then their weak mathematical skills become blatantly obvious.

The students cannot read and interpret graphs, let alone construct a graph of their data. They don't: understand the difference between independent and dependent variables; comprehend issues of scale for the axes; see issues related to the practical meaning of the domain and range. They can't draw a line to capture the trend in data, presuming the points follow a roughly linear pattern. They have even more trouble trying to estimate the equation of that line, particularly because the variables used are almost never x and y. And, because the variables are not x and y, all the practice they've had finding equations of lines in math classes seemingly doesn't apply. Further, the students have trouble interpreting the practical significance of the slope or the intercept of the line, because their mathematical training typically focused on doing calculations, not thinking about what the results mean. They also have trouble calculating the mean, median, and standard deviation, let alone understanding how to interpret them.

Virtually the same issues arise in business and other social sciences when the students likewise have to work with real-world data, although not laboratory data. Thus, one can almost view the social sciences as a somewhat different kind of laboratory science.

The recommendations to provide the mathematical understanding and skills needed for data-driven disciplines represent a significant challenge to the mathematics community. Most of our courses don't meet their students' needs, particular at a time when those fields are becoming increasingly quantitative. The partner faculty are increasingly frustrated with devoting ever more class-time teaching students the required mathematics. Simultaneously, their fields face the challenge of including more new material to reflect changes taking place. Consequently, we should anticipate scenarios where other departments will drop mathematical prerequisite/co-requisites if we don't offer the kind of mathematical experiences their students require; the time and credits saved can easily be off-set by additional courses within the discipline, especially if they already have to teach the needed mathematics.

References

1. Ganter, Susan and Bill Barker, The Curriculum Foundations Project: Voices of the Partner Disciplines, MAA Reports, 2004.

[3] Notices

1. Jennifer Beecher is the McGraw-Hill Representative for *Contemporary College Algebra* 563.584.6323, [jennifer_beecher@mcgraw-hill.com]

2. Joint Mathematics Meetings, New Orleans, LA, January 6-9, 2011

3. **Reunion for Those Interested in Refocusing College Algebra**

   Joint Mathematics Meetings, New Orleans, LA

   Friday, January 7, 5:30 p.m. – 7:30 p.m., Grand Chateau, Sheraton Hotel

   Organizer: Don Small, US Military Academy, Sponsor: CRAFTY