



California Mathematics Council Community Colleges

CMC³ NEWSLETTER



Monterey Conference 2011

*Susanna Crawford,
President-Elect, Solano
College*

It's almost here! Our 39th annual Monterey

Conference will be held **Friday afternoon and evening, December 9th, and Saturday, December 10th**. You should receive your registration form, election ballot, and mini-

program in the mail shortly. If you do not, and for colleagues who might not be members yet and will not receive a form, please download the registration form off the CMC³ website: <http://www.cmc3.org/conference/Monterey11/Monterey11.html>. Also, you can make hotel reservations through this web site. Once you register, Joe Conrad, membership chair, will send you an email confirmation. (Please print your email address very clearly on the registration form!) You will receive your official paper receipt at the conference when you check in. Tell your part-time colleagues to consider coming as well, please.

This year, I especially encourage you to come in early on Friday and stay late on Saturday. There are vendor workshops taking place Friday afternoon as well as the second annual McGraw Hill Math Trivia Event, then in the evening after the keynote speaker Pearson Higher Education is once again hosting Friday night Game Night. You can find out about Friday and Saturday activities by regularly checking back at the Conference link. THANKS to our supportive vendors!

This year we have a fabulous group of presenters scheduled. They are all listed on the web site and in your mini-program. In this article, I want to highlight some sessions. Wade Ellis (CMC³ past president) will be our Friday night keynote speaker and Jo Boaler (Stanford University, School of Education) will be our Saturday keynote speaker. Marilyn Carlson (Arizona State University) will

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Monterey Conference

(continued from front cover)

Speak about research related to Calculus success as well as information about the PCA (Precalculus Concept Assessment) and the PPDM (Pathways Professional Development Model). Ian Walton (Mission College) will update math faculty concerning current state and national projects. Jenny Freidenreich (Diablo Valley College) will explore the use of clickers in the mathematics classroom. For those of you interested in the history of mathematics, John Martin will discuss the history of the Bernoulli family.

The website from Stanford University for our Saturday keynote speaker summarizes her research in the following way: “Mathematics teaching and learning - in particular, how different teaching approaches impact students' learning, how equity is promoted in mathematics classrooms and the opportunities students receive to develop active relationships with mathematics. Gender and learning. The role of groupwork and mathematical discussions in the development of understanding. The ways teachers may be supported in moving towards equitable and effective teaching environments.” She is a well recognized national speaker on Mathematics Education. For many of us, Wade Ellis, this year’s Friday night keynote speaker, needs no introduction. He is simply one of the best national presenters available. In addition those of you who have attended the Monterey CMC³ Conference regularly will recognize Wade

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President's Message

Barbara Illowsky, De Anza College



Welcome to fall term!
Actually, welcome to the middle of fall term!
Each August, I eagerly look forward to this season. I love the start of the new school year,

meeting a new group of students, reuniting with colleagues, pretending that the leaves where I now live turn the vibrant colors of the trees by my childhood home, and, I must admit, joining “some” new committees. However, one of the highlights of each autumn for me is our annual Monterey Conference. This year is no different. President-elect, **Susanna Crawford**, and her team have put together a fabulous conference. (See her article.) We know that travel budgets, if they even exist, are diminishing. Your board has worked really hard to keep expenses down. Some of the publishers are offering workshops on Friday afternoon before the evening reception. You might check at your college to determine if you can include the workshops as part of your professional growth requirements. Plus, you'll have a fabulous time!

As of January 1st, I “retire” as president and become past-president. It has been a great two years serving you as president. I am really proud of the work of CMC³, along with the Foundation's success under the leadership of **Cynthia Speed**. Both organizations have been very successful in supporting faculty professional development while raising funds and distributing student scholarships. At AMATYC, I learned that we host one of the largest regional conferences for mathematics faculty teaching in community colleges.

As I wrote in the summer newsletter, this December, at our conference after-lunch

session, we will hold a general meeting. During that meeting, I will ask for a motion to approve the amended by-laws. If we get a motion and a second, then we will vote. Please review the proposed changes on our web site: <http://www.cmc3.org/news.html>. If you find any typos, please email them to me and I will fix them. If you have questions and/or comments, please send those, as well. Since you will be voting on the changes in December, please read/glance/pretend to read the documents.

I look forward to seeing you in less than three months!



The Sixteenth Annual Recreational Mathematics Conference Call For Speakers

Michael Eurgubian, Santa Rosa College

On April 27th-April 28, 2012, CMC³ will host its Sixteenth Annual Recreational Mathematics Conference at the MontBleu Hotel and Casino in Stateline, Nevada. The format of the conference is the same as that of the annual Fall conference in Monterey, but the session talks are recreational in nature. This means a focus on mathematical topics rather than pedagogy. If you are interested in being a session speaker at this year's conference please contact Michael Eurgubian (707-696-5542, meurgubian@santarosa.edu) for details. You may also submit a proposal on the CMC³ website.

Scholarships

Cynthia Speed, CMC³ Foundation President

The CMC³ Foundation, on behalf of CMC³, awards scholarships to community college students enrolled in the 56 colleges in our region, which extends from the Oregon border to Santa Barbara City College and Bakersfield College. For the last four years, we have been able to award one \$400 scholarship to one-third of the colleges in our region. Next spring, the nineteen colleges that are eligible to nominate one CMC³ Foundation Scholarship winner are Bakersfield College, City College of San Francisco, Contra Costa College, Cosumnes River College, Cuesta College, De Anza College, Diablo Valley College, Gavilan College, Reedley College, Laney College, Las Positas College, Los Medanos College, Merced College, Mission College, Modesto Junior College, Napa Valley College, Santa Rosa Junior College, Shasta College, and West Valley College. The Nomination Forms and Scholarship Criteria document will be mailed to the CMC³ Campus Representatives early next year and are due, with faculty verification signatures, in May 2012.

In addition to these nineteen scholarships, the CMC³ Foundation also awards five scholarships to the top five winners from our region in the Student Mathematics League Competition, which is sponsored by AMATYC. For the last three years the scholarship amounts awarded to the AMATYC SML Competition winners are as follows: first place \$500, second place \$400, third place \$300, fourth place \$200, and fifth place \$175.

The funding for these twenty-four scholarships comes from donations. The current cash donors from July 1st, 2010

through June 30th, 2011 are Anonymous, Charles Barker, Steve Blasberg, Guy De Primo, James Eckerman, Noelle Eckley, Wade Ellis, Michael Eurgubian, Rebecca Fouquette, Patty George, Janet Lee Handel, Richard Hansen, Barbara Illowsky, Marcella Laddon, Gary Ling, A.Podkolzin, Tracy Rabinowitz, Bernard Scanlon, Cynthia Speed, Cynthia Stubblebine, Janet Tarjan, Frederick A. Teti, Binh Truong, Allyn Washington, and Raymond Wuco. This year, we are very much in need of additional funds. If you know of a business, enterprise, corporation, or similar entity that would be willing to help out, please have them contact Cynthia Speed at 707-489-6221 or cspeed@mendocino.edu. If you would like to contribute a cash donation, please mail your check, payable to CMC³ Foundation, to our Treasurer Wade Ellis, Professor Emeritus of West Valley College, 4562 Alex Drive, San Jose, California 95130.

The CMC³ Foundation also oversees and administers a \$500 scholarship for the Student Speaker Competition during the CMC³ Spring Conference at Lake Tahoe. Debra Landre, a former CMC³ President, has sponsored this scholarship for the last several years. Applications are open to any currently enrolled community college student in our region and the paperwork can be found online at www.cmc3.org. Further information regarding the Student Speaker Scholarship is available by contacting Dr. Larry Green at Lake Tahoe Community College, DrLarryGreen@gmail.com or Michael Eurgubian at Santa Rosa Junior College, meurgubian@santarosa.edu.

Math is useless; Is placement testing also useless?

Ken Bull, College of San Mateo

Category	Percent	Standard Deviation	Placements
Transfer Level	16.2%	9.6%	12,539
One level below	19.4%	11.6%	14,986
Two levels below	25.4%	12.4%	19,626
Three levels below	38.9%	24.2%	30,080

Total 100.0% 77,231

I happened upon a very short paper by Craig Hayward on the Cabrillo College website² that analyzed placement test levels for a sample of community colleges in California. For Math, here are the results for $n = 22$ colleges. You may or may not be surprised by these data. One reason that you *may* find the numbers surprising is that Hayward found that there was considerable variability amongst the colleges. For example, placements at “One Level Below” transfer level ranged from 23% to 48% amongst the $n = 22$ colleges. Hence, what he found for his small sample of colleges may well be different from what you see at your college. The variability can also be seen in the standard deviations in the table above. Hayward also warned that his sample of $n = 22$ colleges may not be a representative sample of the 110 community colleges in California.

If the numbers do *not* surprise you, you may be connecting them with your experience with students who have seemingly forgotten what they have learned in elementary school and high school. An obvious instance is arithmetic; it is nearly a commonplace amongst instructors to complain of the students who use a calculator to divide 10 by 5, or other relatively simple calculations. And a second step beyond

observing the tendency to use calculators for simple arithmetic is to note that mental arithmetic – or even paper and pencil arithmetic – is not necessary in today’s world. In other words, arithmetic is fairly useless for everyday life. (As an aside, for an illustration of the opposite I can share my experience of many years ago in Ghana: traders in the markets, many illiterate, were very agile at mental arithmetic with pounds, shillings and pence. Recall that there are 12 pence to a shilling, and 20 shillings to a pound, so “nine half-crowns less one and six is a guinea” although the traders may not have dealt very much in guineas, despite the historical connection to West Africa.)

And if arithmetic is useless, what can we say of the meanings and the use of algebra and geometry? I am informed that the symbols for “less than” and “greater than” are now introduced in the second grade (usually with references to alligators) and reinforced throughout elementary school. Yet, I have met students who have asked me what the symbols mean, and others who have to recreate their understanding of the meanings of the two symbols. Apart from using these in math classes, where else does one use them? Even the distinction between area and perimeter, once surely learned, has to be recalled by many students. We could go on. For direct application (and the word *direct* is intentional) what we teach is pretty much useless except in mathematics courses. If what is taught is not used directly, it is likely to be forgotten, like a language not used.

But as with a language not used, you may be able to retrieve the language. Whether what is forgotten in a language can be retrieved depends on many things: how deeply the language is embedded, length of time since using the language, motivation. But that is getting ahead of our story just a bit.

Enter placement testing, which is the basis for the levels referred to in the paper by Hayward. In looking into just a bit of what is written about

placement testing, I found a large amount of criticism about the system. There are concerns that the testing at the community college level is not consistent with what is being taught in high schools³ and that students are not well informed how to approach the placement testing system⁴. An especially strident criticism can be found in a blog by “Dean Dad” online at “Inside HigherEd”⁵. Underlying many of these criticisms is the idea that the placement test system hampers student success by making many students go through the entire sequence that they have done before. The students have to start at $y = -3$ then move to $y = -2$, then to $y = -1$ before arriving at “transfer level” mathematics. Dean Dad expressed this sentiment as follows:

... the CCRC [Community College Research Center] found that the single strongest predictor of student success that ‘s actually under the college’s control ... is length of sequence. The shorter the sequence, the better they do. The worst thing you can do, from a student success perspective, is to address perceived student deficits by adding more layers of remediation. If anything, you need to prune levels. Each new level provides a new ‘exit point’ –the goal should be to minimize the exit points.

What the research probably noted is what we as math teachers know: generally, those who place into calculus have a higher success rate finishing the calculus program than those who start at, say, the intermediate algebra level. The way Dean Dad has put it (and the way I have heard it) appears to court the classic confusion between correlation and causation; along these

lines, we probably should get the state to raise tuition fees dramatically, since higher tuition fees at the college level are correlated with success.

However, we need not fall into that trap to motivate us to do something about the large proportion of students below transfer level. It is probably sufficient for us to appreciate the daunting prospect of trying to climb out of the $y = -3$ canyon into which a student has been thrown by the placement test. And it is here that the analogy with language (and the uselessness of math) becomes at least a bit helpful. For example, one thing that has been tried at some colleges is to give a short bit of training before a second chance on the placement test. The idea is that perhaps with just a bit of review a student may remember enough of the language to have to climb only part way out of the canyon. If the student truly learnt almost nothing from previous experience, such review will not have much effect. But where just a few things remembered make the difference between spending three semesters or one semesters climbing, such programs are useful. This strategy has had some success where it has been tried in that some students were able to start at a higher level.

Edgecombe⁶ gives a helpful review of some of the ways in which “remediation” has been streamlined in the small paper. Amongst the strategies employed to streamline or accelerate “relearning” are course restructuring, including paired courses (transfer and below transfer level), and offering supplemental support to students taking transfer level courses who do not have the needed background. (The paper also has a helpful short section discussing the very real challenges to implementing these ideas.)

I think the unused language analogy is helpful in other ways as well. My teaching experience is that I constantly overestimate the knowledge and skills that students have readily at hand. Very likely even our better students do not know perfectly what we think they show know or be able to do. But our

better students know how to take care of deficiencies fairly efficiently; they are the ones who say: “Whoa! (or possibly something less placid) Logarithms! Those were confusing” – and then jump to the review sections of the text or perhaps now, online, and do things to revive their acquaintance. (I have the sneaking suspicion that for some students this revisit after some months actually is the time that they come to a greater understanding of the concept; does anyone have good pedagogical evidence for this?) This is the kind of thing good students do. Now, some – but not all – students who place below transfer level might be able to handle even transfer level math if their independent learning skills were developed so that they too had a way of doing what the good students do. Developing independent learning skills is what we would like to train all of our students to do, in any case; it is a kind of global SLO. Our job is to give students feasible resources to do it, and by feasible we mean resources that can actually be used given constraints of work and time. That is not easy to organize, since there is such great variability in what is needed. The kind of thing that could happen is to have modules – probably on line – on matters that we know in advance will be a problem to some minority of students. My question: have we got any examples of this kind of thing working? If so, please share. Bring it to Monterey, if nothing else.

Exercise: Check whether “nine half-crowns less one and six is a guinea” is correct.

Brain Strain

Joe Conrad, Solano College



Welcome back to another academic year and another Brain Strain column! Our new problem is: Determine all polynomials, $P(x)$ such that $P(x^2 + 1) = (P(x))^2 + 1$ and $P(0) = 0$.

Our problem from the Spring Issue was to show that no partial sum (after the first one) of the harmonic series can be an integer. In other words show that

if $n > 1$, then $1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n}$ can never be an integer. We had three solvers: Jim Mailhot, Mel Hom and Paul Cripe. To prove the statement, let's assume that

$$1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} = N \quad (1)$$

with N an integer and find a contradiction. The least common denominator of the left hand side must be of the form $2^k B$ for some odd integer B and integer k with $2^k \leq n < 2^{k+1}$. Multiply both sides of (1) by $2^k B$. We will get:

$$2^k B + \frac{2^k B}{2} + \frac{2^k B}{3} + \dots + \frac{2^k B}{n} = 2^k B N \quad (2)$$

Since $2^k B$ is the LCD, the left hand side of (2) will be a sum of integers with each one having at least one factor of 2 except the one with 2^k in the denominator and this term will reduce to B only. Thus, equation (2) will have an odd left hand side and an even right hand side. This is clearly a

contradiction, so $1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n}$ can never be an integer.

Send solutions to:

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CMC³ Foundation

Cynthia Speed, CMC³ Foundation President

In Spring 2011, the CMC³ Foundation awarded \$6,800 in CMC³ Foundation Scholarships and \$1,575 in AMATYC Student Mathematics League Competition Scholarships. The CMC³ Foundation Scholarship winners and their colleges are

Allan Hancock College	Luke Phillip Larson
Berkeley City College	Esther Rojas-Soto
Cabrillo College	John Poliquin
Cañada College	Francisco Lopez
College of Alameda	
College of Marin	Luis Tercero-Lopez
College of San Mateo	Jessica Yoshiko Kurata
Columbia College	Meghan McKinney
Folsom Lake College	Sam D'Anna
Foothill College	Patrick Keenan
Lake Tahoe Community College	Jared Arnold
Lassen College	Walter Kagel
Merritt College	
Porterville College	Jennifer K. Davis
Santa Barbara City College	Allison Van Pelt
Solano Community College	Bardia Keyoumars
Taft College	Dalton Thornsberry
West Hills College	Lemoore Maria Cortes
Yuba College	Jaime Munoz

The AMATYC Student Mathematics League Competition winners and their colleges are

First Place	Minh Dang Mission College
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Second Place	Kevin Mu West Valley College
Third Place	David Wang West Valley College
Fourth Place	Chan Pong Lei Diablo Valley College
Fifth Place	Xin Ma Ohlone College

The recipients of a CMC³ Foundation Scholarship must meet the following criteria:

- Completed first semester Calculus or higher,
- Declared Mathematics, Physical Science, Computer Science, or Engineering as a major,
- Earned more than 30 semester or 45 quarter units and plans to transfer to an accredited college or university for the next academic year, and
- Earned a GPA of 3.0 or higher.

The following colleges are eligible to award one CMC³ Foundation Scholarship in Spring 2012. The Nomination Form, instructions, and criteria will be mailed to the CMC³ Campus Representatives early next year and are due in May 2012. The students' scholarship checks will be mailed during May & June of 2012.

Bakersfield College	Las Positas College
Laney College	Merced College
Reedley College	West Valley College
Gavilan College	Shasta College
Mission College	Los Medanos College
Cuesta College	Modesto Junior College
De Anza College	Napa Valley College

Diablo Valley College
 Santa Rosa Junior College
 City College of San Francisco
 Cosumnes River College
 Contra Costa College

The funding for our scholarships comes primarily from our member's donations, door prize proceeds, professional organizations, and business contributions. We are preparing for our Fall Mathematics Conference in Monterey and are seeking donated items for our Scholarship fund-raising activities. Please contact any of the Foundation Board members if you have any prizes, puzzles, books, or any other miscellaneous items that you wish to donate for our drawing. The Foundation Board members are Wade Ellis from West Valley College, Larry Green of Lake Tahoe Community College, Wei-Jen Harrison of American River College, Debbie Van Sickle of Sacramento City College, and Cynthia Speed from Mendocino College.

We are deeply grateful to all of our Donors and they will be acknowledged in the Monterey Conference Program. This fiscal year, the donors from July 1st, 2010 through June 30th, 2011 are Anonymous, Charles Barker, Steve Blasberg, Guy De Primo, James Eckerman, Noelle Eckley, Wade Ellis, Michael Eurgubian, Rebecca Fouquette, Patty George, Janet Lee Handel, Richard Hansen, Barbara Illowsky, Marcella Laddon, Gary Ling, A.Podkolzin, Tracy Rabinowitz, Bernard Scanlon, Cynthia Speed, Cynthia Stubblebine, Janet Tarjan, Frederick A. Teti, Binh Truong, Allyn Washington, and Raymond Wuco. Please consider joining this list of Donors by completing the attached Donation Form and mailing your donation to Wade Ellis, Emeritus of West Valley College.

Former CMC³ President, Debra Landre, has promised to donate \$500 to sponsor the Student Speaker Competition at the CMC³ Lake Tahoe Spring Conference. Next April 2012, there will be another opportunity for one of your students to compete for this great scholarship. Applications, instructions, and selection procedures are available on our CMC³ website, <http://www.cmc3.org>. Please help us recruit applicants by announcing this wonderful opportunity to the students and faculty at your college. The winner will receive a \$500 check and a marble plaque.

The Foundation relies heavily on your generous donations to fund scholarships. Please consider making a donation to the CMC³ Foundation Scholarship Fund so that we can continue to honor our most gifted, talented, and deserving students. Whether your donation is \$5, \$10, \$25, \$100, \$500 or more, we thank you for your continued contributions. CMC³ Foundation is a non-profit charitable organization under section 501(c)3 of the Internal Revenue Code. Contributions are tax deductible to the extent allowable under federal law. Our Tax Identification Number is 94-3227552 and no goods or services are provided in exchange for these donations. Please complete the attached donation form and mail your donation to

Professor Wade Ellis
 Emeritus of West Valley College
 4562 Alex Drive
 San Jose, California 95130

Please accept my donation payable to
CMC³ Foundation in the amount of:

\$5____, \$10____, \$20____, \$50____,
\$100____, or Other _____

Name _____

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City _____ State ____ Zip ____

College or

Company _____



Monterey Conference (continued from page 2)

Ellis as the smiling man with the amazing voice who calls winners every year for our CMC³ Foundation fundraising event. I am looking forward to hearing both of these phenomenal speakers.

I appreciate those of you who volunteered to be presidors via the online submission form. We were able to fill some of the slots that way, but still need lots of new volunteers. Please consider applying. If you are interested in presenting at CMC³ Monterey Conference next year, we have already posted the speaker proposal form and the presidor proposal form for 2012. Please help Mark Harbison (Sacramento City College), next year's Conference Chair, out by sending in your great proposals.

December is almost here. I look forward to seeing you in Monterey!

What's Happening at College of San Mateo

Jay Lehmann

For the past several years, College of San Mateo has been undergoing a facelift, erecting fabulous new science and student-center buildings. Several other buildings have been renovated.

The math department has also undergone some changes. Michael Burke has retired, after teaching for 41 years, including 35 years at CSM. Mike has designed new courses, taught abroad, and served on the President's Council. Lena Feinman has been hired as a full-time faculty. Lena Feinman has taught courses, served as the adjunct faculty contact person, and helped coordinate the math resource center for years as an adjunct faculty. She is excited about her new position.

For the past several years, Cheryl Gregory and Ken



Brown have worked hard to direct math faculty to develop SLOs. We are using students' performance on core finals as an instrument to help us evaluate our department's effectiveness. In particular, we are retooling our algebra courses, checking whether students are improving. We have reduced the number of topics in Elementary Algebra and have reduced the amount of review in Intermediate Algebra. It's too soon to say if this is a good move.

Due to closer state scrutiny of hours by arrangement (HBA), now renamed To Be Arranged (TBA), the entire college has been scrambling to ascertain what constitutes as TBA.

Due to budget issues, we have temporarily discontinued our "express algebra course" (Elementary Algebra and Intermediate Algebra taught together in one semester). Our department continues to experiment with online homework and hybrid (online) courses.

Through the History Glass

J. B. Thoo, Yuba College, jthoo@yccd.edu



Complex numbers are a topic we typically introduce for the first time in intermediate algebra. The “classic” example for motivating a need for complex numbers is the quadratic equation $x^2 + 1 = 0$ that has no real-number solution. However, the equation that truly prompted a serious study of complex numbers is the cubic equation $x^3 = 15x + 4$ that has the real-number solution 4. *Why would a cubic equation that has a real-number solution*

spur a study of complex numbers? Let us see.

The story begins with the formula for solving cubic equations using radicals that was found by Italian mathematicians in the sixteenth century. Today this formula is commonly referred to as Cardan’s cubic formula, and you may recall the Tartaglia-Cardano controversy over the priority of the formula.¹ The solution of the cubic equation and the quartic (biquadratic) equation were certainly a watershed in the history of algebra, and more persons were involved in those achievements than only Niccolò Tartaglia (1500–1557) and Girolamo Cardano (or Cardan; 1501–1576). The principal players were Scipione del Ferro (1465–1526), Tartaglia, Cardano, Ludovico Ferrari (1522–1565), and Raphael Bombelli (1526–1572), and, in an unintended way, Luca Pacioli (1445–1517).

Pacioli declared at the end of his *Summa de arithmetica geometria proportioni et proportionalita* (1494) that solving the cubic equation would be as impossible as solving the ancient problem of squaring the circle. This discouraged many good mathematicians, including Cardano at first, from seeking a solution of the general cubic equation using radicals, but it also laid down the gauntlet to others to find such a solution. As it turns out, not only was Pacioli mistaken here, but the first crack at a solution to the general cubic would be made within twenty years of his declaration in the *Summa* by his compatriot del Ferro of the University of Bologna. In steps, del Ferro, Tartaglia, and Cardano found a method for solving the general cubic equation, and Cardano’s pupil Ferrari found a method for solving the general quartic (by reducing it to a cubic).

What del Ferro found was a method for solving “the cube and first power equal to a number,” that is, in modern notation, $x^3 + px = q$, where p and q are any positive real numbers. Not only was this a pivotal breakthrough in the search for a solution of the general cubic, but also eventually Cardano’s approach to solving $x^3 + bx^2 + cx + d = 0$ is to apply the change of variable $x = y - b/3$ to obtain the reduced cubic equation $y^3 + py + q = 0$

that is then solved. Cardano shows this in his seminal work, *Artis magna, sive de regulis algebraicis* (*The Great Art, or the Rules of Algebra*; 1545), commonly called the *Ars magna*.

In modern notation, the cubic formula for solving the reduced or depressed cubic equation $x^3 + px + q = 0$, where p and q are any real numbers, is

$$x_1 = r + s, \quad x_2 = r\omega_2 + s\omega_3, \quad x_3 = r\omega_3 + s\omega_2,$$

where

$$r = \sqrt[3]{-\frac{q}{2} + \sqrt{\frac{q^2}{4} + \frac{p^3}{27}}}, \quad s = \sqrt[3]{-\frac{q}{2} - \sqrt{\frac{q^2}{4} + \frac{p^3}{27}}},$$

and $\omega_2 = -\frac{1}{2} + i\frac{\sqrt{3}}{2}$ and $\omega_3 = -\frac{1}{2} - i\frac{\sqrt{3}}{2}$ are the complex cube roots of unity. We stress, however, that during Cardano’s time mathematics was written almost entirely in prose and, because only positive coefficients were allowed, he considered thirteen separate cases of the cubic equation, with each method yielding only positive real solutions and generally neglecting nonpositive real or complex solutions.

The cubic equation $x^3 = 15x + 4$ that prompted a serious study of complex numbers appears in Bombelli’s own seminal work, *L’Algebra* (1569). (Prior to this, one would say simply that an equation like $x^2 + 1 = 0$ or $x^2 + 2x + 2 = 0$ has no solution.) In *L’Algebra*, Bombelli says,

... I have found another kind of cubic root of a polynomial which is different from the others. This [cubic root] arises in the chapter dealing with the equation of the kind $x^3 = px + q$, when $p^3/27 > q^2/4$, as we will show in that chapter. This kind of square root has in its calculation [algorismo] different operations than the others and has a different name. Since when $p^3/27 > q^2/4$, the square root of their difference can be neither positive nor negative... [This new kind of root] will seem to most people more sophisticated than real. This was the opinion I held, too...

The quantity $\frac{q^2}{4} + \frac{p^3}{27}$ that appears inside the square root in the cubic formula is the discriminant of the cubic equation. When the discriminant of a cubic equation is negative, not only are we confronted with complex numbers in the cubic formula, but also with cube roots of complex numbers. And during a time when complex numbers were not understood, and not even considered to be numbers, cube roots of complex numbers were even more mysterious. This is known as the irreducible case. Now we know that a cubic equation has a full set of distinct real roots when the discriminant is negative.

By direct substitution, we see that the real number 4 is a solution of Bombelli’s famous equation $x^3 = 15x + 4$. Bombelli knew this. Throwing caution to the wind, however, Bombelli also fearlessly applies the cubic formula to the equation and finds the solution

$$x = \sqrt[3]{2 + \sqrt{-121}} + \sqrt[3]{2 - \sqrt{-121}}.$$

¹http://www-history.mcs.st-andrews.ac.uk/HistTopics/Tartaglia_v_Cardan.html

Could it be that this weird expression that contains the square root of a negative number—objects that mathematicians often called “sophistic,” “impossible,” “imaginary,” and “useless”—is the real number 4? The answer is, yes, and Bombelli’s genius was to assume that the two cube roots are complex conjugates, that is,

$$\sqrt[3]{2 \pm \sqrt{-121}} = a \pm b\sqrt{-1},$$

even though there was absolutely no reason for one to think so. Having made this bold assumption, he then cubed both sides of the relation, collected terms, and deduced that

$$a^3 - 3ab^2 = 2 \quad \text{and} \quad 3a^2b - b^3 = 11.$$

Now, guessing that $a = 2$, substitution into the system yields $b = 1$. Therefore, Bombelli concludes that

$$\sqrt[3]{2 \pm \sqrt{-121}} = 2 \pm 11\sqrt{-1},$$

so that

$$x = \sqrt[3]{2 + \sqrt{-121}} + \sqrt[3]{2 - \sqrt{-121}} = 4.$$

Consequently, there must be something to these “sophistic,” “impossible,” “imaginary,” and “useless” objects—these square roots of negative numbers—after all, and so began a serious study of complex numbers that eventually led to the fundamental theorem of algebra.

About all this, Bombelli says interestingly,

It was a wild thought in the judgement of many; and I too for a long time was of the same opinion. The whole matter seemed to rest on sophistry rather than on truth. Yet I sought so long, until I actually proved this to be the case.

Moral: The next time you introduce complex numbers, mention Bombelli’s famous equation, $x^3 = 15x + 4$.

Previous columns are on the Web at <http://ms.yccd.edu/~jb2/histglass.html>.

References

- [1] William P. Berlinghoff and Fernando Q. Gouvêa, *Math through the Ages: A Gentle History for Teachers and Others*, Oxtan House Publishers, Farmington (2002).
- [2] David M. Burton, *The History of Mathematics: An Introduction*, 6th edition, McGraw-Hill, Boston (2007).
- [3] Girolamo Cardano, *The Rules of Algebra (Ars Magna)*, translated and edited by T. Richard Witmer, Dover Publications, Inc., Mineola (2007).
- [4] Federica La Nave and Barry Mazur, “Reading Bombelli,” *The Mathematical Intelligencer*, Vol. 12 No. 1 (2002), pp. 12–21.

CMC³ Board Elections

Larry Green, Lake Tahoe Community College



It’s time again to vote for the new CMC³ board that will be sworn in after the fall Monterey conference. Mark Harbison from Sacramento City College is running unopposed for president. Over the past several years Mark has

done a stellar job as business liaison and will surely make a wonderful president. Rebecca Fouquette from Santa Rosa is also running unopposed for treasurer. She has done a fantastic job over the past two year to make sure that our finances are in order. For Secretary, the incumbent, Greg Daubenmire, from Las Positas College is running against our adjunct advocate, Tracey Jackson, from Santa Rosa Junior College. There are four member-at-large positions open and there are five members running: Steve Blasberg, Greg Daubenmire, Katia Fuchs, Tracey Jackson, and Marcella Laddon. Since either Tracey Jackson or Greg Daubenmire will be elected secretary, we have just the right number of candidates to ensure that all the positions will be filled. Bic Dovan and Hsiao Wang are running for the two positions on the foundation board. I sincerely thank all of our members who have shown their dedication to CMC³ by running for the board. All current CMC³ members will find a ballot enclosed with their registration packet that will come in the mail shortly.

Using the ClassPad to Explore Mathematics

Pre-Conference Presentation

Friday, December 9th, Redwood I, 3 pm – 5 pm

Presented by:

Diane Whitfield, dwhitfield@casio.com, CASIO Product Manager, Mathematics adjunct at Portland State University and Portland Community College

If you are wondering what the ClassPad is or if it will help students better visualize mathematics, please attend. The audience will learn how to drag, drop and explore mathematics in a new way with activities that range from basic Algebra to entry level Calculus. The ClassPad truly is an amazing tool. One ClassPad 330 handheld and one CASIO Exilim camera will be given away during the workshop!!



The Monterey Poster Session is Back and Better Than Ever!

By Rebecca Fouquette, Santa Rosa Junior College

It's back!! The annual CMC³ Monterey poster session will be occurring during the Saturday sessions this year at our Monterey conference. This poster session offers community college students a chance to participate in our conference through the creation of a poster to display. Posters can involve any level of mathematics that extends the usual curricula (no book problems!). Independent study projects or modeling problems are encouraged. New this year, we are offering a prize of \$75 for the best poster and \$25 for the runner up. There is no fee to enter and the student gets free registration.

For a student to submit a poster, he or she should be a current community college student for

Fall 2011 and a current CMC³ faculty member must sponsor the student. Students will be asked to provide an easel to display their work. Faculty sponsors are asked to ensure their sponsored student is able to attend the conference, that the student has all the materials he or she needs and supervise the set up and clean up of the poster.

Posters will be displayed during the Saturday conference. Students are asked to be available to answer questions on their poster during an assigned time. Any interested students should complete an abstract and submission form available now on our website, www.cmc3.org. Submissions will be accepted until November 25, 2010. For more information contact Rebecca Fouquette at rfouquette@santarosa.edu.

Dear Editor,

I think it's terrific that the CMC³ Newsletter is now available on the World-Wide Web, even if it's only a facsimile of a printed copy for now. It's a very good start and I applaud you for that. I look forward to an electronic version of the Newsletter that is enhanced for reading on desktop or handheld devices. However---notwithstanding the monetary savings in printing and postage, and perhaps an altruistic effort to go "green"---I lament that I no longer receive a printed copy of the Newsletter in the mail.

I have always viewed receiving a printed copy of the Newsletter as a privilege of membership in CMC³. I would wait in anticipation for it to arrive in the mail. A printed copy was nice to handle, easy to read, easy to read *_anywhere_*, and easy to share with others. Now I have to stare at a computer screen to read the Newsletter, an experience I find to be cold (compared to the warm experience of holding and reading printed matter).

I would like to suggest that CMC³ return to sending her members printed copies of the Newsletter, or at least offer her members the choice of receiving either a printed copy or an electronic copy. Moreover, I would like to suggest that the current electronic copy be available to members only as a privilege of membership, and only archived copies be available to the general public.

Thank you.

Yours sincerely,
John Thoo.
Yuba College

Dear Editor,

I am waiting to express how pleased I am with the new online newsletter. I have been striving over the last few years to reduce my own carbon footprint by minimizing the amount of paper that flows in and out of my life and eventually into the waste basket. I am also pleased that in these economically challenging times our organization can now put the hundreds of dollars we have spent to print and mail the newsletter to other important uses. Way to go green folks!

Debbie Van Sickle
Sacramento City College



What are YOU doing?

Barbara Illowsky, De Anza College

Did you recently take a sabbatical? Develop a new program for helping students succeed? Participate in a conference or workshop overseas? Shorten the proof of Fermat's Last Theorem? Work on a national committee? Please consider sharing with us your activities. So many of our members are doing innovative, interesting activities. Yet, we seldom hear even about our own campus colleagues' sabbatical projects or off-campus mathematics experiences. Please consider writing a brief article about what you have been up to. You might even make a new friend who has similar interests! Send articles to:
mathnerdjay@aol.com.

Friends of the Foundation

Cynthia Speed, Foundation President

The CMC³ Foundation would like to acknowledge the generous support of the following individuals and organizations during 2010-2011. We wish to express our heartfelt thanks and appreciation to these contributors whose donations have made possible the number of scholarships that the Foundation has awarded to community college students in northern and central California. CMC³ Foundation is a non-profit charitable organization under section 501(c)3 of the Internal Revenue Code. Contributions are tax deductible to the extent allowable under federal law. Our Tax Identification Number is 94-3227552 and no goods or services were provided in exchange for these donations. These contributions were donated from July 1st, 2010 through June 30th, 2011.

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Math Nerd Musings

Jay Lehmann,
College of San Mateo



I've taught math for twenty-two years. Our profession is one of the few where that doesn't sound like very long. In fact, one of my colleagues retired last spring

after teaching thirty-five years, and he was surprised to learn that I'd *only* been teaching for twenty-two.

Nonetheless, I've been teaching long enough to know my strengths and my weakness all too well. In fact, after about ten years, I reached a plateau, where I'd maximized my strengths and minimized my weaknesses as best as I could. My standards are pretty high and so are my success rates, but you'd think I would've seen some improvement since then.

Early in my career, I attended a workshop on public speaking. It was quite helpful in a number of ways, but the one thing that scared me to death was an exercise on eye contact. I had to stand in front of the room, make eye contact with just one participant, say a complete sentence, wait for the person to nod, and then move on to the next participant, repeating this sequence until all twelve attendees had nodded, one by one. Well, I somehow survived the exercise. Never mind my pounding heart and sweaty palms.

My fear of eye contact is kind of bizarre, because I don't seem to have any trouble locking eyes when one-on-one. And I've presented at over fifty conferences nationwide and have performed at even more rock-band gigs in the past thirty years. But the

thing is, when I'm in front of a group, I tend to look at people in the back row.

Even after attending the workshop, I mostly look at the students in the back row. By now you're thinking, well come on, just give everyone equal attention. And I would, but within seconds of teaching each class, I'm concentrating on so many other things that come into play, such as trying to be clear and budgeting time. Plus, I get pretty swept away by the excitement of talking mathematics. I realize this might sound pretty nerdy in some circles, but I'm sure you understand. So it's more that I *catch* myself looking at the back of the room when I come up for air.

You might say, does it really matter? Well, apparently it does. A lot. Over the years, I've noticed in quite a number of my classes that students in the back tend to have the best attendance and hang in there for more of the semester, even if they're doing poorly. And they often do in fact perform poorly. Not really surprising, given that weak students often choose to sit as far as way from the instructor as possible.

It's ironic. Here I am focusing on the very students who are trying to avoid me, meanwhile ignoring those in the front rows who *do* want to connect. What's odd is that it was only until this summer that this obvious observation really sunk in. I finally understood on another level that the students in the front rows really do want to connect with me (and the material).

Apparently this observation has made all the difference, because this semester I am able to give lots of eye contact to those in the front rows. Somehow, all the pressure has been released. When I look at students, it feels quite natural and relaxed. We're just hanging out, talking mathematics. And the benefits have been huge. Students are asking a lot more questions,

and not surprisingly, many of those questions are coming from students up front. And my office hours have been jam-packed.

One downside to relating better with my students is that I'm not able to get through as much material, due to the uptick in student questions. And, yeah, I know, what's the point in racing through the material if many students are lost? But I do sometimes wish students would ask fewer questions, although I'm riding this new experience out to see where it goes.

Even though I've made major progress this semester, I sometimes still catch myself looking mostly at the students in back. And I've realized I tend to do that when I'm rushing. So, everything is pointing in the same direction: slow down and make eye contact with all students. In other words, be fully present. That is, create space in my lectures for me to connect with my students and for them to let me know how they're doing. You know, a true conversation.

Not a bad lesson to learn about conversations in all walks of life.

But there's an even larger lesson for me that goes beyond eye contact and connection. What I've learned is that even when I've done something for a long time and have plateaued, there is still the opportunity for a quantum leap in improvement. Even if I've already given an issue a lot of thought, or already tried to improve in number of ways, there still may be an observation or experience that will set me free to transform some weakness into a strength.

So in my next ten years or so of teaching, I look forward to other positive transformations, and hope you have a bunch of your own.

Calendar

October 9, 2011 CMC³-South Mini Conference, San Diego City College, San Diego, CA. Contact: Hoat Le, (619) 388-3639, email: hle@sdccd.edu

November 10-13, 2011 AMATYC 37th Annual Conference, Austin, TX. Contact: AMATYC Office, (901) 383-4643, email: amatyc@amatyc.org

December 9-10, 2011 CMC³ 39th Annual Conference, Portola Hotel and Spa, Monterey, CA. Contact: Susanna Crawford, (530) 864-7000 x-4614, email: susanna.crawford@solano.edu

January 4-7, 2012 MAA-AMS Joint National Meeting, Boston, MA. Contact: MAA Office (202) 387-5200, email: maahq@ma.org

February 25, 2012 MAA Northern California Section Meeting,

Mathematical Sciences Research Institute, Berkeley, CA. Contact: Stephen Devlin (415) 422-6509, email: smdevlin@usfca.edu

March 2-3, 2012 CMC³-South 27th Annual Conference, DoubleTree Hotel, Orange, CA. Contact: Sherri Wilson, (909) 389-3336, email: swilson@craftonhills.edu

March 2-4, 2012 Teachers Teaching with Technology, Chicago, IL. Contact: Renee Hartshorn, (888) 282-8233, email: rhartshorn@ti.com

March 22-25, 2012, 24th Annual International Conference on Technology in Collegiate Mathematics (ICTCM), Orlando, FL. Contact: Joanne Foster (800) 472-6288 or (207) 676-8688, email: joanne.foster@pearson.com

April 25-28, 2012 NCTM 90th Annual Meeting, Miami, FL. Contact: NCTM Office (703) 620-9840, email: annlmtg@nctm.org

April 27-28, 2012 CMC³ 16th Annual Recreational Math Conference, MontBleu Resort Casino and Spa, South Lake Tahoe, NV. Contact: Mike Eurgubian, (707) 778-2474, email: meurgubian@santarosa.edu

July 8-15, 2012 12th International Congress on Mathematical Education (ICME-12), Seoul, Korea. Contact: Sung Je Cho, email: sungjcho@snu.ac.kr

November 8-11, 2012 AMATYC 38th Annual Conference, Jacksonville, FL. Contact: AMATYC Office, (901) 383-4643, email: amatyc@amatyc.org

December 7-8, 2012 CMC³ 40th Annual Conference, Portola Hotel and Spa, Monterey, CA. Contact: Susanna Crawford, (530) 864-7000 x-4614, email: susanna.crawford@solano.edu

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