California Mathematics Council Community Colleges

2016 Monterey Conference Coming Soon!

Katia Fuchs, President Elect, City College of San Francisco

The 44th annual CMC³ Fall Conference will be held this year on Friday and Saturday December 9-10, 2016. We will once again be at the Hyatt Regency Monterey Hotel and Spa. Just like last year, we will have all our conference activities on the upper level of the conference center. We will continue to enjoy the free in-room Wi-Fi and free parking, and although we continue to offer the free shuttle to downtown Monterey, we will only offer it on Saturday. The shuttle will run from 6pm to midnight on Saturday, and will make trips between the lobby of the Hyatt Regency and downtown Monterey, by the Portola Hotel and Spa. Our group room rate remains the same at $139 per night for up to double occupancy. You can make reservations online at https://resweb.passkey.com/go/2016CMC3 (Note that the hotel services fee will be waived at check-in even though it may appear in the projected costs online.) If making reservations by phone, mention "CMC³ Group Rate" when calling Hyatt Passkey Reservations: 888-421-1442. For more information on the hotel, please see the hotel website at www.monterey.hyatt.com/en/hotel/home/html.

We are also happy to announce that we are continuing our Travel Grant Program. This is designed for those who are new to CMC³ or our colleges. It provides free registration, one year of membership, and covers one night for one half of a double-occupancy room at the hotel. One faculty person from each of our 59 colleges is eligible. Please consider sponsoring one of your newer faculty members. The deadline for submission is Nov. 1. For more information, see www.cmc3.org/conference/montereyConferenceGrant.html.

There will be an exciting program again this year that will offer a wide range of sessions appealing to many areas of professional development and classroom interests.

(see "Monterey Conference" on p. 3)

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CMC[3] Newsletter is the official newsletter of the California Mathematics Council, Community Colleges, and is published three times a year--in the spring, summer, and fall.

Mark Your Calendar:

44th Annual CMC[3] Conference

December 9th and 10th, 2016

Hyatt Regency Monterey Hotel and Spa

Monterey Conference

(continued from front cover page)

Our Friday night keynote, titled Mathematics 2.0, will be presented for us by Spiros Michalakis from Caltech. Dr. Michalakis earned his PhD in Mathematics from UC Davis, and currently splits his time between research on quantum many-body physics and outreach to the public, including being a science consultant for Hollywood movies!

Our Saturday keynote, titled A Tale of Two Internets, will be presented for us by Dan Meyer from Desmos. Dr. Meyer earned his PhD in Mathematics Education from Stanford University, and is currently the Chief Academic Officer at Desmos, where he explores the future of math, technology, and learning.

Back by popular demand, we will once again have Game Night (hosted by Pearson) on Friday night after the Keynote speaker, and the Estimation Run/Walk first thing on Saturday morning at 7:30am. The full list of speakers and their titles, as well as the latest information about the conference, is available at the conference website: www.cmc3.org/conference/Monterey16/Monerey16.html
You should soon be getting the official mini-program and registration form via US Mail. Please note that for the first time this year, online registration will be available! Please feel free to disseminate the information and copies of the registration form among your colleagues, both full time and adjunct! We are excited to see everyone in December!

CMC^3 History Quiz, Part 7

Mark Harbison, Sacramento City College

1. Rearrange the letters "Mentor Ye" to form the name of a great place to meet for a math education conference every year: _____ .

2. In what year did Howard Anton give the keynote *Applications of Calculus Done Right!* in Monterey?

3. Which Tahoe conference included the first Debra Landre "Student Scholarship Speaker" on the program?

4. What was the topic of Keith Devlin's 2012 Monterey keynote talk?

5. There were ten CMC^3 Board Members listed on the 1973 Monterey program. How many of them can you name from memory?

(see "Answers to History Quiz" on page 12)

President's Report

Joe Conrad, CMC³ President, Solano Community College

As I write this we are about one-third of the way through the fall semester. Time is flying by as we approach our fall conference in Monterey! Conference chair and president-elect Katia Fuchs has done an excellent job preparing a program filled with exciting, informative talks and punctuated them with two awesome keynote speakers. I am looking forward participating in another great conference and getting together with all of you!

In another exciting note, we are happy to announce that for the first time we will be offering the opportunity to register and pay online. Folks have been asking for this option for quite some time. You should receive a miniprogram in the mail as always which will include the traditional paper registration form. You are welcome to use the paper form or do online registration at http://www.cmc3.org/conference/Monterey16/registration.html. Note that there are two steps to the process. First, you will fill out and submit the form that has the data needed for us to process the registration and have your nametag and receipt ready for you at the conference. After noting the amount due and submitting that form, you will go to step two which is paying with a credit card or Paypal account.

Again this year, due to a generous donation from Wei-Jen Harrison, the CMC³ Foundation will be sponsoring Travel Grants intended to assist people who have never attended a Monterey conference. The grant includes a paid registration and one-year membership as well as an $80 stipend that would cover a night for one person in a double-occupancy room. Each college is permitted one grantee, so check out the details at http://www.cmc3.org/conference/montereyConferenceGrant.html.

Finally, I encourage everyone to consider mentoring a student in the annual student poster contest. We have added a second category for poster awards, namely for posters that explore math history as well as the traditional posters exploring a math problem. For more information, see: http://www.cmc3.org/conference/callForPosters.html.

All this information and much more including speaker information can be accessed at the conference website: http://www.cmc3.org/conference/Monterey16/Monterey16.html.

Please consider putting one or two newsletters in the copy room for other instructors to read.

Math Nerd Musings: Curiosity

Jay Lehmann, Newsletter Editor, College of San Mateo

We've all heard that by the time students reach community college, all their curiosity has been beaten out of them. And to to be sure, there are plenty of students who just want to know how do a mathematical procedure without being told the conceptional underpinning. This can be painfully apparent during office hours, when you can just feel a student push their mental pause button as you explain the concept but then perk up when you go over the steps.

As a parent, I tried to protect my son Dylan's curiosity by responding to his questions without going on and on—not an easy thing for me! Sometimes he'd have follow-up questions so we'd end up talking about a topic for quite a while, but other times my succinct response to his initial question would satisfy him.

I'm happy to say that even with Dylan having left for college (just two weeks ago), he still has a strong sense of wonder and curiosity about physics, human interaction, and the infinite. But I can't take credit. He's the one who's preserved his curiosity. I just didn't squash it.

But Dylan's not the only one who's stayed open to learning about the "why" of things. In my calculus class, I don't have a single math major, and I assumed that few students wanted me to prove the various theorems of the course. But in taking an anonymous survey, I was surprised to learn that 80% of the class wanted me to continue proving theorems.

But they're calculus students. Surely trigonometry students would be less inclined to learn the "why." After 27 years of teaching, I've arrived at the assumption that students tend to tune me out when I discuss concepts. To test my assumption, after lecturing on the unit circle and how it can be used to determine the range of the trigonometric functions, I asked students to explain this on a test. I was surprised to learn that a large proportion of the students had been listening, although some expressed the concept much better than others.

To see some evidence that many community college students are still curious about mathematics is encouraging, but what can we do to avoid squashing students' curiosity, or even better, encourage it? One tack would be to sort out the equivalent of my strategy in responding to Dylan's questions. A fairly close strategy would be to incorporate a lot of group activities, especially if they have a discovery component to them. I've shared in a previous column that I have been using more and more group work in my courses. The more I reduce my time spent lecturing, the more opportunities I have for groups of students to discover cool math concepts. I've found time and time again that students are able to discover/make sense of many concepts that I used to lecture on.

I want to uncover other assumptions I've made about my students that underestimate their true passion to learn.

And it's not just students who benefit from curiosity. In response to my calculus and trigonometry students surprising me, I want to uncover other assumptions I've made about my students that underestimate their true passion to learn. By removing more of my blindspots, I hope to enhance students' love and curiosity of mathematics.

Student Poster Contest

Jennifer Carlin-Goldberg, Santa Rosa Junior College

It's time to tell our students about the CMC^3 Poster Contest! Our Student Poster Contest is a great way for our students to showcase the great work that they do beyond the classroom. This year, however, we have made one important change, we now have two categories! Traditionally, student math posters have been about exploring a problem beyond the normal curricula. We now have an additional category for students who want to explore a topic in Math History.

Motivated students at all levels are welcome to submit a poster. In previous years, we had wonderful posters submitted from beginning algebra, statistics and calculus students and we hope to continue this wonderful diversity this year. Modeling problems are encouraged!

There is no fee to enter and the student gets free registration, including lunch. (only one per poster submission) The first place winners in both categories receives a $100 scholarship and the second place winners receives a $50 scholarship. A special thank you to Binh Truong, from American River College, whose generous donation allowed us to offer larger awards for the poster contest this year.

Posters will be displayed during the Saturday conference only, so student participants must attend Saturday and are encouraged to attend the entire conference. Each poster needs to have a presenter that is available to present his or her poster when the poster is being judged during the sessions before lunch and to answer general questions from 12:30-12:45. Awards will be presented during the Saturday keynote session. Posters will be judged on mathematical/ mathematical-history content, the student's explanation of poster, and overall poster appeal. Students are encouraged to prepare a 2-3 minute synopsis of their project ahead of time. Submissions will be accepted until November 25, 2016.

For a student or student group to submit a proposal, please go to http://www.cmc3.org/conference/callForPosters.html.

Requirements: For a student to submit a poster, they should

- be a current community college student for Fall 2016,
- have a current CMC^3 faculty member who will attend the conference and sponsor them,
- provide an easel to display their work, and
- be able to attend the Saturday conference

We are also looking for volunteers from our membership to help judge the wonderful submissions we receive. You will be asked to judge each poster by ranking them, on a scale from 1 to 5 in each of the above mentioned areas. Judging will take place during one of the

morning sessions. If you are willing to volunteer to be a judge or have any other questions, please contact me at jcarlingoldberg@santarosa.edu

Let's get the word out and make this a fabulous year for the CMC^3 Poster Contest and our students!

What's Happening at Sacramento City College

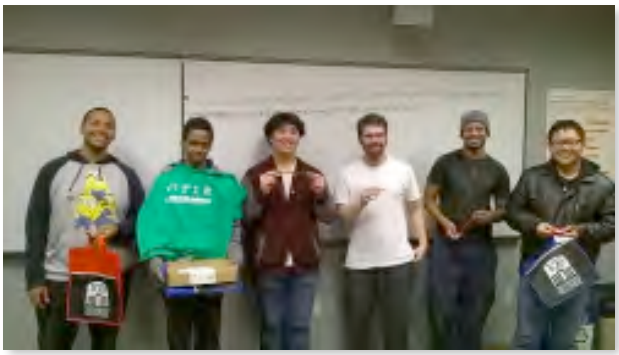
Mark Webster

Hiring!

After the long hiring drought during the Great Recession, SCC has had a hiring El Nino for several years. This year we hired two new mathematics faculty Cindy Dibble and Tricia Sanford, and one engineering faculty Lu Li. Welcome aboard. We look forward to many years of their fresh energy.

Moving!

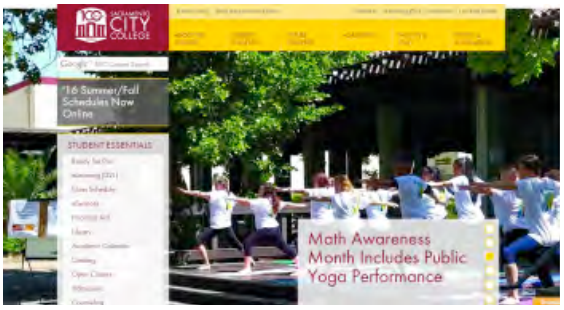
For decades, the SCC math department has been too big for our offices to fit into one part of one building. As a result, we were scattered across three buildings. Our high priority for years on the department unit plan was to gather all of the faculty into one area to increase



communication and camaraderie. It seemed an impossible dream but this spring it happened. We are still going through the moving pains but are all in part of one floor of the Rodda North building. The "new office" smell is strong and we're still figuring out where to hang our cartoons, but we made it.

Pi Day Contest

The Learning Resource Center sponsored a "Name the most digits of Pi" contest for rounded Pi day 3/14/16. The winner, Travell Criner, listed 133 digits from memory (and



won an apple pie and several other gifts). Second place Joshua Pauly knew 92 digits. Dare you to go up against these students!

Math Awareness Month

As we've been doing for several years, each April we celebrate National Math Awareness Month with displays and activities around campus. This year Professor Trinidad Stassi and college students put on a display of Math and Yoga, and Math and New Zealand Poi Balls. It was so well received that the college president had a photo put on the front page of the SCC website.

Affordable Textbooks

Like many community colleges, a high percentage of our students are below the poverty line and have difficulty paying for the ever growing cost of college textbooks. Several instructors have adopted open source (free) textbooks this fall 2016 under the AB 798: College Textbook Affordability Act of 2015 for community and state colleges grant. This and other funding allowed us to loan students textbooks for the entire semester in our lowest level arithmetic classes, Math 27 and 28.

What's Happening at Modesto Junior College

Hardev Dhillon

There are many fascinating things taking place in mathematics education at Modesto Junior College. Faculty are researching and implementing creative offerings for math courses.

We are in the last year of

implementing the HSI-STEM (Hispanic-Serving Institutions) grant funded by the Department of Education. With this five-year grant, we have been able to offer extended tutoring for math courses and Supplemental Instruction for our STEM classes such has Precalculus and Elementary Statistics. In addition, we have served approximately 1,000 students with Math Jam which consists of intensive math review sessions designed to prepare students for their upcoming math courses or math assessment tests. This grant has also funded equipment for recording lectures and lessons which assist students with reviewing notes and studying particular topics online. This has been a tremendous asset for our distance education program throughout our math and science courses.

Our department is continuing to offer 50% hybrid classes and bringing back 99% hybrid classes. These courses are designed to serve the needs of our students who find it challenging to attend a traditional face-to-face course. In addition, our campus is making the transition to Canvas from Blackboard for our distance education classes.

Beginning Spring 2017, our Calculus I and Calculus II courses will be offered in a completely new model. Our traditional 5 unit courses will now be in the model of a 4 unit course plus a 1 unit optional problem solving course. This model was developed as a compromise to address the issue of high unit courses at our campus.

Finally, our department is continuing to offer accelerated courses which consist of two models. One model is Elementary Algebra + Intermediate Algebra (STEM) in a one semester offering for a total of 10 units. The other model is Elementary Algebra + Intermediate Algebra (Non-STEM) in a one semester offering for

a total of 9 units. We are researching a STEM pathway for math which would begin at Beginning Algebra and continue through the Calculus sequence and a Non-STEM pathway which would begin at Beginning Algebra and go through a transferable math course which is not part of the Precalculus/Calculus sequence. The department is also researching nontraditional compressed pathways from algebra through statistics.

Book Review: *Math Girls, Math Girls^2 and Math Girls^3* Author: Hiroshi Yuki Translator: Tony Gonzalez

Dean Gooch, Santa Rosa Junior College

At the Joint AMS/MAA Conference of January, 2014 in San Antonio, I happened upon a table for Bento Books, a Japanese Publisher where I met Tony Gonzalez who was hawking the "Math Girls" series of books that he was in the process of translating from the original Japanese. He had copies of the first and second volumes, *Math Girls* and *Math Girls^2* subtitled, *Fermat's Last Theorem.* The third volume, *Math Girls^3*, subtitled*, Gödel's Incompleteness Theorems* had not yet been printed. It took me a while to get around to reading these books, but once the third book came out I was intrigued and read the series in reverse order.

The "Math Girls" series of teen novels centers on the mathematical lives of four youths, Yuki, Miruka, Tetra and Yuri. Yuki is the author as a youth, Miruka is a brilliant young mathematician who seems to know so much for her young years, Tetra is a bright underclasswoman who seeks mathematical help from Yuki, and Yuri is Yuki's bright and always-questioning sassy cousin who is in middle school and pretty much hangs out at Yuki's house on weekends since she lives nearby.

All of the triumphs and failures of learning are very well depicted in this series. Everyone, including the brilliant Miruka, is struggling to learn about life and mathematics together in a marvelously collaborative way. Their mutual friendships develop as they walk to the train station, drink coffee and try to solve challenging problems together. Some of the problems are mysteriously handed to the students by the mathematics *sensei* Mr. Muraki.

Topics that are addressed in the first book are recurrence relations, generating functions, the harmonic series, the Basel Problem and partitions. The later volumes are equally rich. Most of the mathematics is well explained since it comes in the context of youths explaining the concepts to each other in usually more than one way. A little bit of differential and integral calculus would help the reader, but is not necessary since it is all explained to Tetra and Yuki who have never seen calculus.

There are also three other shorter novelettes that are more topic-oriented. They are *Math Girls Talk about the Integers, Math Girls talk about Trigonometry* and *Math Girls talk about Equations and Graphs.* There is even a *manga* form of the first *Math Girls* book. All of these books are meant to cultivate mathematical interest in youths by presenting interesting and, at times, humorous stories. This series is said to be wildly popular in Japan.

At one point in *Math Girls Talk about the Integers*, Yuri presents some cards to her older cousin Yuki and says, "Prepare to be astounded as the amazing Yuri preforms the mystifying Number Guessing Trick!" To which Yuki explains, "I don't think magicians announce tricks like that!" Yuri retorts, "Just shut up and watch!" to which the older Yuki replies, "Yes Ma'am." From there they go into an explanation of the Binary Card Number Trick.

I found these books captivating and recommend them to anyone, especially to a young person who feels an inclination to dabble in the mathematical arts.

The Pleasures of Problems

Kevin Olwell, San Joaquin Delta

Fall 2016: Winnie the Pooh and Piglet go to visit each other. They leave at the same time and each walks at a steady pace. Because they are preoccupied counting the blackbirds flying overhead, they pass by each other without realizing it. Pooh gets to Piglet's house 1 minute after they pass while it takes Piglet another 4 minutes to get to Pooh's house. How long did it take Piglet to get to Pooh's house?

Summer 2016: Suppose $a, b \geq 0$. If the polynomial $f(x) = x^3 + ax^2 + bx + 1$ has three real roots, then $f(2) \geq 27$.

Solutions (or a sketch of a solution) were submitted by Carlos Valencia, Fred Teti, Joe Conrad, Lakshmi Vanniasegaram, and Brad Krein.

Since $a, b \geq 0$, if $x \geq 0$, then $f(x) \geq 1$. Thus the three roots are negative, say $-u$, $-v$ and $-w$. Multiplying out the factored form of $f(x) = (x+u)(x+v)(x+w)$ gives

$$a = u + v + w \qquad b = uv + uw + vw\ .$$

At this point all but one solution applied Lagrange Multipliers to the formulas for a and b subject to the constraint $uvw = 1$. Routine calculations yield minima when $u = v = w = 1$. Since $a \geq 3$ and $b \geq 3$, the smallest $f(2)$ can be is 27.

An alternative method is to apply the Arithmetic Mean-Geometric Mean Inequality to both a and b:

$$\frac{a}{3} \geq \sqrt[3]{uvw} = \sqrt[3]{1} \text{ and } \frac{b}{3} \geq \sqrt[3]{(uvw)\text{^}2}.$$

As before $a, b \geq 3$. Thus if $x \geq 0$ we have

$$f(x) \geq x^3 + 3x^2 + 3x + 1 = (x+1)^3.$$

The AM-GM Inequality can be also be used to show that if $f(x)$ is a monic polynomial with n real roots, nonnegative coefficents, and $f(0) = 1$, then the coefficient of x^k is at least as big as the coefficient of x^k in $(x+1)^n$. As in the summer problem, this gives $f(x) \geq (x+1)^n$, provided $x \geq 0$.

All are invited to submit a solution to the Fall 2016 problem either via email or US mail at the address below.

Kevin Olwell
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5151 Pacific Avenue
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Anyone is welcome to attend our board meetings. If you'd like to attend, please contact anyone on the board. We'll be happy to tell you the date and location of our next meeting.

Art Dull, CMC^3 Founding Member, Passes Away

Joseph Conrad

We are sad to report that Art Dull retired math instructor passed away on Friday, August 19, 2016.

Art joined the DVC math department in 1965. He received his B.A. from College of the Pacific in 1956 and his M.A. in Mathematics from University of Utah in 1964. Art served on all department committees, was elected twice as department chair, served as the vice-president of the academic senate, was staff development coordinator from 1989 to 1992, and also served as faculty advisor for the math department. In 1971, Art transferred to LMC to open their mathematics department. While at LMC until 1975, he served as the first academic senate president, and with Les Birdsall, developed the mathematics program, the personalized system of instruction and the highly successful math lab. As a representative of DVC, he was elected chairperson for the seventy-five Fullbright Exchange Teachers to Great Britain (1968-69). He was honored by the California Mathematics Council for Community Colleges being given their Teaching Excellence Award and their Distinguished Service Award. He was one of the founders of CMC3 and was elected as their 5th president. Art retired in 1996.

CMC^3 Foundation Report

Mark Harbison, Foundation President, Sacramento City College

The CMC^3 Foundation supports students in CA Community Colleges who are majoring in mathematics and show great potential. With the tremendous help of donors like you, we have been more generous to these students than any other agency around. For example, Katherine Kays-Hoepker earned a $ 3000 scholarship for leading the Sierra College Math Club and earning all A's in 8 courses from College Algebra to Linear Algebra. A full winners list with photos is in the previous newsletter issue and also on the web page www.cmc3.org/foundation.html#scholarships.

For the next round, eligible students will be those who are enrolled in at least 6 semester units as of Feb. 1, 2017, when the forms will be available here www.cmc3.org/foundation.html#CMC3_Foundation with full eligibility criteria. Applications will be due by Mar. 15, 2017.

The Foundation also supports the Monterey Student Poster Session, including a free lunch for students who participate: www.cmc3.org/conference/callForPosters.html .

With the support of Debra Landre, a CMC^3 Past-President, the Foundation continues to support a student speaker at the annual Recreational Mathematics Conference in South Tahoe. If you know of a student who would appreciate a $ 500 prize for giving a 30-minute talk, then be sure to nominate that student soon www.cmc3.org/conference/callForProposalsTahoe.html !

And thanks to another very generous donation from Wei-Jen Harrison, one of the founding members of CMC^3, we are pleased to offer Travel Grants for a 2nd year in a row. www.cmc3.org/conference/montereyConferenceGrant.html. Last year, only about half of the 59 colleges in our area took advantage of this opportunity, so surely we can spread the news even more this year to increase the number of new members. Free membership, registration and $ 80 towards Hyatt lodging sounds like a good incentive, right?

Everyone who is a member of CMC^3 is also a member of the Foundation. Our members and other supporters can help us continue our scholarship programs by supporting us in the following ways.

- Make a tax-deductible cash contribution**.
- Donate prizes for our raffle. The value of these items is also tax-deductible*. Donations can include (but are not limited to)
  - Wine, beer, etc.
  - Candy, cookies or other non-perishable foods
  - Gift cards for stores, restaurants, or services
  - New re-giftable items
- Purchase our t-shirts and other items for sale at our table during the conferences.

Thank you very much for supporting our students, on behalf of the CMC^3 Foundation Board of Directors: (Treasurer)

Leslie Banta and (Members-at-Large) Shawn Lanier, James Sullivan and Casey Terrill.

** CMC^3 Foundation is a nonprofit charitable organization under section 501(c)3 of the Internal Revenue Code. Contributions are tax deductible to the extent allowable under federal law (as long as no goods or services are provided in exchange for the donation). Our Tax Identification Number is 94-3227552. Cash donations can be made in four ways:

- When you register for either conference by postal mail (Please use a separate check, but mail it in the same envelope as your registration form.)
- With the 'donation' button on http://cmc3.org/foundation.html
- In person at one of our conferences, either by check, cash, or credit card
- By mailing a check to our treasurer, Leslie Banta at Mendocino Community College, 1000 Hensley Creek Rd, Ukiah, CA 95482

Answers to CMC^3 History Quiz

(continued from page 3)

1. **Monterey** is the best place in CA to visit every December for professional development in mathematics education, at least since 1973.
2. Dr. Howard Anton has been primarily an author since 1983 (formerly a member of the Drexel Univ. faculty). He gave the **1999** CMC^3 Monterey keynote talk.
3. The Student Speaker Scholarship, courtesy of Debra Landre, has donated $500/year for a different student each year, starting in **2009**.
4. Keith Devlin (Stanford Univ.) gave a 2012 Monterey keynote titled *The Symbol Barrier—Using **Video Games** to Overcome the Greatest Obstacle to Good Mathematics Learning*.
5. James **Curl** (MJC), Ray **Wuco** (Delta C.), Art **Dull** (DVC), Les **Birdsall** (DVC), Betty **Luan** (ARC), (Mike) Frank **Denney** (Chabot C.), Pat **Boyle** (SRJC), Al **Utterback** (Cabrillo C.), Sister Clarice **Sparkman** (SJCC), and Brandon **Wheeler** (SCC) were the original ten CMC^3 Board Members in 1973. When possible, please say thanks to them for their leadership.

The Need for "Proofs and Mathematical Reasoning" Courses at Community Colleges

Dean Gooch, Santa Rosa Junior College

A recent mandate from state legislators suggested that students who transfer to four-year institutions from community colleges should be able to finish their degrees in two years after transfer. One major for which this is highly problematic is the mathematics major.

Most four-year institutions have a required course that is the transition course from lower division work to upper division work in the mathematics major. This course is usually called something like "Proofs and Mathematical Reasoning," and is largely unavailable at community colleges.

There are several problems with offering a "Proofs and Mathematical Reasoning" type course at a community college.

The first difficulty is that of initially offering this class at a community college. Until the popularity of the class grows, the class would likely be under filled and potentially cancelled by administrators. Since there are relatively few students who transfer as mathematics majors, these classes will start out with small numbers. I believe that the number of mathematics majors will increase soon since more high paying jobs are becoming available in fields like data mining and cryptology. Also courses in number theory are becoming necessary in other technical fields and number theory requires knowledge of proofs and mathematical reasoning.

Another problem is that many four-year institutions offer their course in proofs and mathematical reasoning as a junior level course. Since a community college course cannot articulate as an upper division course, a student who has completed a proofs and mathematical reasoning course at a community college must petition to be allowed to take courses that have the proofs course as a prerequisite or retake the proofs course at that four-year institution.

At UC San Diego, its proofs and mathematical reasoning course is upper division. In spite of this, students are expected to take this course at the end of their sophomore year. This course is necessary in order for students to be able to start taking the upper division courses that are required for the mathematics major. Modern algebra and real analysis have the proofs course as a prerequisite.

A former student who was not able to take the proofs course at my school found that she was completely shut out of the modern algebra and real analysis sequences in her first year as a junior at UC San Diego because she did not have a proofs course the previous year. Subsequently, her senior year was so packed that it made her course work very difficult.

Recently, I visited City University of New York, CUNY, in Harlem. This institution offers undergraduate and graduate degrees in mathematics. I spoke to one of the undergraduate advisors to discuss their curriculum. I noticed that their proofs and mathematical reasoning course was an upper division course. I asked if the students there took this course in their junior year. The advisor scoffed and informed me that any student who waited until their junior year to

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Through the History Glass

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Fractions—$1/2$, $2/3$, $7/5$—are a favorite topic of our developmental and remedial students. We have a feeling that they were also a favorite topic of students since antiquity! In this installment, we present how fractions were represented by various peoples at different times.

Babylonian

The Babylonians, who sprang from the region of Mesopotamia about 5500 years ago, used a base 60 place-value number system. To write a fraction, they extended the place values to include 60^{-1}, 60^{-2}, 60^{-3}, and so on, just as we do with tenths, hundredths, and thousandths. The number $0;37,30$, therefore, represents $37 \times 60^{-1} + 30 \times 60^{-2} = 5/8$. Complicating such a sensible system, however, was the fact that the Babylonian number system had no place holder or separatrix (a mark that separates the whole number part of a number from its fraction part). Thus, the fraction $0;37,30$ would really have been written 37 30 using their cuneiform writing, and one would have to determine from context whether this represents $0;37,30$ ($5/8$) or $37;30$ ($37\,1/2$) or $37,30$ (2250), or something else. Interestingly, some fractions that are nonterminating in base 10 are terminating in base 60, and inversely.

Egyptian

The ancient Egyptian number system was not a place-value system. In their hieroglyphic writing, they had symbols for 1, 10, 100, 1000, and so on, and used as many of these as necessary to represent a number. They generally expressed fractions as sums of unit fractions, that is, fractions that have numerator 1. They represented unit fractions by putting a mark over a whole number. For example, $\bar{2}\bar{8} = 1/2 + 1/8 = 5/8$. Of course, there are more ways than one to express a given fraction as a sum of unit fractions; but, it appears that the Egyptians held to four basic rules.

1. Use four or fewer fractions.
2. Use even denominators.
3. Use a larger denominator for the first fraction. (They wrote from right to left.)
4. Do not repeat a fraction.

There were special symbols for the fractions $1/2$, $1/4$, and $2/3$, which were among the most commonly used fractions.

Roman

We are familiar with Roman numerals for whole numbers. For fractions, the Romans used duodecimal (base 12) fractions, and had special names and symbols for them. (We omit the special symbols in the following table.)

uncia	$1/12$	septunx	$7/12$
sextans	$1/6$	bes	$2/3$
quadrans	$1/4$	dodrans	$3/4$
triens	$1/3$	dextans (decunx)	$5/6$
quincunx	$5/12$	deunx	$11/12$
semis	$1/2$	as	1

Cajori [1] tells us that the fraction $5/6$ was commonly called *semis et triens* ($1/2 + 1/3$) instead of *decunx*. He also tells us that the Romans did use other bases for fractions, giving the example that silver was measured in tenths (base 10) of a *denarius*.

Indo-Arabic

In the Bakhshālī Manuscript (thought to be from between the eighth and twelfth centuries AD), found in 1881 near the village of Bakhshālī in modern Pakistan, for example, we find that the Indians of that time wrote fractions like we do today, with the numerator above the denominator, but *without* a fraction bar.

Cajori [1] tells us that the first known use of a fraction bar is found in a work of the twelfth-century AD Arabic author, al-Ḥaṣṣâr, who instructed: "Write the denominator below a [horizontal] line and over each of them the parts belonging

to it; for example, if you are told to write three-fifths and a third of a fifth, write thus, $\frac{3}{5}\frac{1}{3}$."

According to Katz [2], decimal fractions (tenths, hundredths, thousandths, and so on) were not used in Europe until Simon Stevin (1548–1620), a Dutchman, introduced them in his work *De Thiende* (*The Art of Tenths*; 1585). This is how Stevin describes his new notation, where "unity" refers to 1: "And each tenth part of the unity of the commencement we call the *prime*, whose sign is ①, and each tenth part of the unity of the prime we call the *second*, whose sign is ② and so of the other; each tenth part of the unity of the precedent sign, always in order one further." In Stevin's notation, then, 3⓪1①4②1③ denotes what we would write today as 3.141 or $3\frac{141}{1000}$.

Finally, our use of a point or comma for a decimal separatrix was introduced by John Napier (1550–1617) of logarithms fame in his work, *Rabdologia* (1617). Still, other methods were also used, which Cajori [1] tells us, quoting a comment by Samuel Jeake in 1696: "As to express 34 integers and $\frac{1426}{10000}$ Parts of an Unit, they do it thus, $34.^{/}1.\ ^{//}4.\ ^{///}2.^{////}6.$ Or thus, $34.^{(1)}1.\ ^{(2)}4.\ ^{(3)}2.\ ^{(4)}6.$ Others thus, $34{,}1426''''$; or thus, $34{,}1426^{(4)}$. And some thus, 34.1 . 4 . 2 . 6 . setting the Decimal Parts at little more than ordinary distance one from the other..... [others] $34|\underline{1426}$. And sometimes the Cöma is inverted thus, 34'1426.. . ."

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Previous columns are on the Web at <http://ms.yccd.edu/history-glass.aspx>. Thoo is coauthor with Amy Shell-Gellasch of *Algebra in Context: Introductory Algebra from Origins to Applications*, Johns Hopkins University Press, Baltimore (2015), that presents introductory algebra using history as the vehicle.

References

[1] Florian Cajori, *A History of Mathematical Notation: Two Volumes Bound as One*, Dover Publications, New York (1993).

[2] Victor J. Katz, *A History of Mathematics: An Introduction*, 2nd ed., Addison Wesley Longman, Reading (1998).

Proofs

(continued from page 13)

Their students traditionally take it prior to the junior year as well.

I talked to a recent mathematics graduate of UCLA who was not a transfer student. UCLA does not require nor offer a proofs and mathematical reasoning course. When I mentioned the concept to her, the student said that it would have been much nicer for her if there had been one offered at UCLA.

Four-year institutions such as UC Irvine, UC Santa Barbara, Sonoma State University and Cal Poly San Luis Obispo all have lower division proofs and mathematical reasoning courses. The proofs and mathematical reasoning course that I created at Santa Rosa Junior College articulates to these institutions. Thus students who transfer to these institutions with this course completed can take any of the upper division courses for which this is a prerequisite upon arriving at those institutions.

UC Santa Barbara and UC Irvine indicate in their catalog that they would prefer students to take the proofs and mathematical reasoning course as early as they can. In fact in UC Irvine's catalog, it is suggested for all mathematics majors and minors that the proofs course be taken in the freshman year as soon as that student has finished the second quarter of calculus.

It seems that the solution is two-fold. Four-year colleges need to renumber their proofs and mathematical reasoning course as a lower division course or allow easy transfer of an equivalent course. Also, more community colleges need to teach this course so that students will be competitive with their non-transferring peers. This is not only important for those students seeking a degree in mathematics, but is becoming increasingly important as industry's technological needs require a greater understanding of mathematical reasoning.

Bull: Group Work for Faculty

As an innovative and effective teaching strategy, we often extol the benefits of group work for students. Should we recommend group work for faculty? Bull thinks so.

Earlier this year, Bull participated in one of those short "e-mail flurries" among colleagues that we occasionally experience. The conversation included thoughts on teaching statistics and pre-stats courses, as well as the place of pre-stats courses in the curriculum. Most of the participants were experienced instructors, though only a very few of them would regard themselves as statisticians. At one point, the conversation turned to innovative texts for introductory statistics, of which there are now some very good examples. Colleagues expressed admiration for the innovative texts, but also expressed concern about how to "teach like them"; that is, how to teach like the authors of the innovative texts intended. There seemed to be a big gap between the way these experienced teachers were accustomed to teaching, and methods implied by the texts. Spanning that gap appeared to be daunting to some.

One answer to spanning such gaps, to learn new ways, is to form a faculty group. Rather than trying to innovate as a teacher singlehandedly, trying to "teach like them" alone, it may be better to innovate as a part of a support group.

What constitutes faculty group work?

We need at least a working definition of faculty group work. Here is a start: Let us say that faculty group work consists of a collection of instructors (≥ 2) who intentionally use the same teaching materials in the same way. That is, the teachers will use the same text (or videos), the same assignments (exercises, projects), the same assessment materials, the same time-table for the course, and the same course policies for multiple sections of the same course.

This is a working definition, and necessarily looser than definitions math people typically want: if one of the "same" elements is missing or relaxed, we would still call the arrangement group work. However, on the other hand, let us agree that merely teaching from the same text does not constitute group work; no, there must be more substantial and intentional coordination among instructors before the benefits and challenges of group work can be felt. (See the next sections.) Even though something like a discussion group for people teaching individually from the same text may certainly be of help, what is envisioned here is a more substantial and intentional cooperation.

Also, although this definition may look like a definition of "team-teaching" it is intended to be broader. Team teaching often implies that the students in a particular section will see more than one instructor. Our definition can be applied to several instructors teaching different sections, but intentionally teaching in the same way. The sections of the same course could even be at different colleges.

Benefits of group work for faculty

Listing both the benefits and the challenges seems to lend itself to a bullet point format. To start, here are some possible benefits. To each one, it is possible to take a critical eye,

and say: "Well, that *may* happen, but not necessarily . . . ". True, but the list is meant as a starting point for thinking; assess the benefits after reading the challenges as well.

- Support for innovation. Working as a group affords support for implementing innovative teaching. It helps to have a group to plan for forays into uncharted territory – a group of people to discuss strategy, for example – and to reflect and review on what has been done together.
- Division of labor. Working as a group allows some division of labor. As an example, one person can be tasked with creating tests to be vetted by others. (For some teachers, this mention of tests being made by colleagues may raise a red flag; see the section on challenges). Setting up course management systems to get them to do what you want them to do, and only what you want, is a skill that not all teachers have in abundance, but some in the group may have. Collaboration with tasks divided may lead to higher quality materials, if the collaboration works well. At the very least there are others to catch typographical errors.
- Flexibility for students. Several sections running according to the same time table, including times for tests, can accommodate student schedules.
- Adjunct inclusion. Group work provides a way of incorporating adjunct faculty more closely in the life of the department without bureaucratic hassle (e.g. departmental meetings, required reports). Group work as described here may or may not include formal meetings. Moreover that there can be a division of labor may appeal to some adjuncts who are relieved of part of the work of a separate course preparation.
- Consistency in teaching. Potentially, group work can result in more consistency among sections of the same course without burdensome rules and regulation. Working as a group can strengthen a teacher's resolve against (for example) pleas from students for postponing test dates. Temptations to use class time in unprofitable ways can be resisted. There is a discipline in working with others.

Challenges of group work for faculty

- Synchronization of sections. The last item above mentioned discipline of working with others, especially in terms of what is done with class time. That same discipline can also be seen as a constraint in seizing opportunities that arise in class. At times, scheduling to keep the sections synchronized, and making multiple versions of tests (necessary because there are many sections running the same program) is an additional task. However, the experience of those who have done group work (including this writer) indicates the extra tasks do not pose insurmountable problems.
- A work culture of individualism. As teachers, we are not accustomed to working as a team for the most part. We tend to see classes as "my classes" and tend to have definite opinions about how things should be done. ("I always tell my classes. . ."). Working as a part of a team requires a certain amount of give and take that is foreign to many instructors. There are mitigating factors, however, that make group work easier. If a group is formed with

the intention of doing something new, the pull of "old and established" will be less forceful. Coordinating sections with a common format but retaining the instructor of record for each section does allow each instructor to put his or her individual touch to the teaching. Group work need not be rigid or legalistic. While it is most likely useful that the group have a leader, the leadership should not be overbearing and should allow collegiality.

- Concerns about academic freedom. Where group work is entered into voluntarily, perhaps even for a limited time, and there is a good measure of collegiality, issues of "academic freedom" that arise for example where instructors are forced to follow a departmental decision can be dampened.

Reflection

Group work described here has some affinities with "Lesson Study" which was described in the Bull column in Summer 2015 newsletter (See: `http://www.cmc3.org/Newsletters/CMC3Spring15Reduced.pdf`). More about lesson study can be found at `http://professionallyspeaking.oct.ca/march_2010/features/lesson_study/`, and there are now workshops available (some of them local) for community college folk who wish to know more. Possibly our working definition of faculty group work needs to be modified to include work on lesson study.

Group work for faculty, especially for innovation, raises another interesting issue: What is really important for long term student learning? Is it how the teacher inspires, motivates, explains in the class? Or, ultimately, is it the experiences that the student goes through: the exercises, the projects, the slogging? Which really makes the long term difference? Students, Bull thinks, would gravitate to the first answer – the teacher – if asked. Moreover, much of teaching culture and advice (the structure of our classes, the way instructors are assessed) also presumes that it is teacher's leadership or personality that is really important. This view may lead to the idea of teachers as heroes or superstars. It may be quite exhilarating (or intoxicating or perhaps disheartening) to imagine oneself as "teacher superstar". But the kind of group work proposed here looks in a different direction: more focused on introducing, using or refining what students *do* as a part of their educational experience. Bull (as in previous posts) would push for emphasizing the second more than is often done, without denying the importance of the individual teacher. Refining and implementing innovative student experience is more easily done by instructors together rather than singlehandedly.

Very likely the dichotomy (teacher and experience) is a bit misleading in that both are important – the teacher and what students do – and there are other aspects of teaching (caring and prompt feedback on errors in homework, for example) which appear to straddle the dichotomy and are also important. The question that started this column: "how to teach like them" presumes the first perspective, but the authors of the innovative texts are looking at the second perspective. But working as a team may lead to a situation where the important influence of the teacher can be yoked to more significant experiences for the student.

Ken Bull

Calendar

October 14–15, 2016: MichMATYC Annual Conference, Delta College, University Center, MI. Website: www.michmatyc.org

October 26–28, 2016: NCTM Western Regional Meeting, Phoenix, AZ. Contact: NCTM Office (703) 620-9840, email: regconf@nctm.org

November 4–5, CMC South Conference, Palm Springs Convention Center. Website: http://www.cmc-south.org/

November 17–20: AMATYC 42nd Conference, Denver, CO. Contact: Keven Dockter, e-mail: keven.dockter@anokaramsey.edu

December 2–4, 2016: CMC North Conference, Asilomar State Conference Center & Pacific Grove Middle School Pacific Grove, Monterey Peninsula, CA. Website: http://cmc-math.org/about-2/

December 9–10, 2016: CMC³ 44th Annual Conference, Hyatt Regency Monterey Hotel and Spa, Monterey, CA. Contact Katia Fuchs, City College of San Francsico, (510) 325-1616, efuchs@ccsf.edu

February 17–18, 2017: MAA-FTYCMA Joint Conferences, State College of Florida, Bradenton Campus. Website: http://sections.maa.org/florida/newsletter/callscfb.htm Contact: C. Altay Özgener

February 25, 2017: Sacramento Valley Community College Math Conference, Yuba College

March 3—4, 2017: CMC³ South Conference, Kellogg West Conference Center & Hotel (tentative dates). Contact: Cheryl Vallejo, e-mail: vallejocheryl@hotmail.com

March 9–12, 2017: ICTCM 28th Conference, Chicago, Illinois, http://www.pearsoned.com/events-and-webinars/ictcm/

April 7–9, 2017: 50th Annual NYSMATYC Conference, Syracuse, NY. Contact: Phil Loud. Website: www.nysmatyc.org

April 21–22, 2017: 21st Annual Recreational Mathematics Conference, Lake Tahoe Community College. Contact Larry Green (530) 541-4660 ext. 341, drlarrygreen@gmail.com

November 9–12, 2017: AMATYC Conference, San Diego

December 8–9, 2017: CMC³ 44th Annual Conference, Hyatt Regency Monterey Hotel and Spa, Monterey, CA.

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