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California Mathematics Council Community Colleges

President's Report

James Sullivan, CMC^3 president, Sierra College

A new fall term is upon us and many of you are hard at work teaching revised curriculums, incorporating active learning strategies in your classrooms, building genuine relationships with your students to enhance your culturally responsive instruction, supporting students in need of just in time remediation, applying equitable grading practices, providing your students with meaningful and actionable feedback, and developing and implementing authentic assessments. To everyone who is incorporating any or all of these recommended practices into your teaching this term, I commend you. I also recommend that you be mindful and take the time to practice self-care to keep yourself healthy, both mentally and physically, and to keep these desirable practices sustainable. One way to help you accomplish this is to reconnect and restore yourself by attending this year's CMC^3 Fall Mathematics conference in beautiful Monterey. Now, to anyone who is not aware of or who has not yet adopted any of these advantageous teaching practices, I recommend that you attend this year's CMC^3 Fall Mathematics conference to learn about the benefits of these valuable educational strategies.

Either way, I hope to see each and every one of you at the 2022 CMC^3 Fall Mathematics conference in Monterey on December 9th and 10th. This conference promises to be a joyous celebration. It not only marks our return to an in person conference after two years of pandemic induced virtual conferences, but it also coincides with our organization's 50th annual Fall Mathematics conference. These are all good reasons for us to come together, reconnect, restore, celebrate, and support each other.

Please visit the CMC^3 Fall conference webpage (https://www.cmc3.org/conferences/fall/) to view the conference program and access links to register for the conference and make your hotel reservation. You don't want to miss out on the opportunity to be a part of our 50th anniversary celebration.

Contents

This CMC^3 newsletter wants to know how your school is doing! Our community is always proud to see developments in other departments and campuses across Northern California, but unfortunately, this editor has been unable to contact anyone interested in writing up what has been happening on their campus recently. I would love to share how campuses are moving as we head into this new era of teaching. Please email me at rhodesj@smccd.edu if you are interested in being featured in your usual "What's Happening" article so we can all take a look at the magnificent progress we as a Mathematics teaching community continue to make.

50^{th} Anniversary Fall Monterey Conference

Cortney Schultz, President Elect, Santa Rosa Junior College

This year will be our 50th Annual CMC^3 Fall Conference, and we are so excited to be holding it *in person* for the first time since the beginning of the pandemic! The conference will be held on Friday and Saturday December 9-10, 2022 at the Hyatt Regency Monterey Hotel and Spa.

Like in years past, all of our conference activities will be on the upper level of the conference center, and the "Downtown Monterey" shuttle will be running on Saturday night. However, as this year is our 50th anniversary conference, we have some extra special presentations and surprises in store for you.

Our group rate is $165 per night for single and double occupancy rooms. The hotel's service fee is reduced to $10 per room, per night, and includes self and valet parking, guestroom wireless internet, and access to the fitness center, pools and hot tubs. You can make reservations online at the link: https://www.hyatt.com/en-US/group-booking/MRYDM/G-CM3C If making a reservation by phone **(+1 831 372 1234)** make sure to mention the "CMC^3 Group Rate". To ensure your group rate, please reserve your room by **November 10, 2022**.

So much has happened since the last time we congregated in person – This year's conference theme is *Reconnect & Restore*.

Our vision for this conference is to give space for our members to reconnect with each other and share their experiences after teaching through a pandemic and isolating for the last 2 years. We also want to celebrate all of our wonderful members who have supported us in these past 50 years.

Kicking off the conference on Friday night, we are going to have a special 50th Anniversary celebration! We will hear from two CMC^3 Past Presidents reflecting on their experience being involved with CMC^3, their career as an educator, how roles of math educators have changed over the years, teaching anecdotes, and the best teaching advice that anyone has ever given them. After the presentations, attendees will help us create a time capsule to be opened at the 75th CMC^3 Fall Conference.

Our Saturday keynote, titled "Cultural Identity Central to Native American Persistence in STEM" will be presented by Dr. Nizhoni Chow-Garcia (Diné) and Dr. Naomi Lee (Seneca). Dr. Chow-Garcia is Diné, born to the Tódích'íi'nii (Bitter Water People) and To'tsohnii (Big Water People) clans. Her academic and professional areas of interest are broadly in the field of diversity and inclusion and more specifically in working to increase the success of Native Americans in higher education, supporting women and students of color in STEM, and engaging in critical Indigenous frameworks and methodologies. Dr. Naomi Lee is an Assistant Professor in the Department of Chemistry and Biochemistry at Northern Arizona University. Her research focuses on peptide-based vaccine development and health disparities among Native American populations.

Sessions on Saturday will include sessions related to supporting students in STEM, equity, relevant math legislation, and more.

With all of the wonderful speakers and presentations, don't forget about the extra fun! After the Friday presentation, join us for game night. This year, we're putting on a BINGO night complete with snacks and a cash bar. And don't forget about the Estimation Run/Walk first thing on Saturday morning at 7:30am.

Last but certainly not least, please encourage your students early this fall to develop a poster for presentation at the conference! We understand that travel to Monterey may not be possible for all students, so we will be providing both an in-person and a virtual submission option this year. Presentations will be judged in the week leading up to the conference, and cash scholarships up to $300 will be awarded to the winners. Go to https://www.cmc3.org/students/posters/ for more details about the student poster contest.

You can find the latest information about registration, hotel reservations, speakers, and presentations on the conference website: https://www.cmc3.org/conferences/fall/ Online registration is planned to open mid-October.

We are so excited to see you all back in Monterey this year for our 50th Anniversary! Thank you for your continued support.

Upcoming Conferences

CMC^3 Fall Conference: December 9-10 at the Hyatt Regency in Monterey 48^{th} AMATYC Annual Conference: November 17-20, 2022 in Toronto

The History Corner

Joe Conrad, Solano Community College

This is my first column as a retiree! As of the end of Spring Semester, I have joined the ranks of the unemployed. During my 34 years of full-time college teaching, my favorite course to teach was Calc II and my favorite part was series. The simplest series for students are p-series. Of course, p-series are fundamental for doing comparison tests and for developing a basic understanding of how series work. We show the harmonic series ($p = 1$) diverges and, thus, gives a counterexample to the hope that if the terms of a series converge to 0, then the series converges. Because Euler is my favorite mathematician of all time, I talk quite a bit about the sum of the reciprocals of the squares of the natural numbers and how Euler made a name for himself by discovering the exact sum of this series thus succeeding where many before him, including Newton, Leibniz and the Bernoulli's, had failed. The purpose of this article is to look at this result and to go to the next step, namely, what is the sum of the series of the reciprocals of the cubes of the natural numbers? I'm sure that you recognize that what is being discussed is usually referred to as values of the zeta function. For now, we define $(\zeta(x) = \sum_{n=1}^{\infty} \frac{1}{n^x}$, where x is a positive integer. The harmonic series, $\zeta(1)$, was proven to diverge by Oresme in the 1300's. (See this column in Fall 2020 for more details.) Pietro Mengoli (1625 – 1686) was the next to prove the divergence of the harmonic series and asked about $\zeta(2)$; does it converge and, if so, what does it converge to? John Wallis (1616 – 1703) wrote about the problem in 1655 and computed the value of the sum to three decimal places. Jacob Bernoulli (1655 – 1705) spent considerable effort in finding the value of $\zeta(2)$ and wrote in 1689, "If anyone finds and communicates to us that which has thus far eluded our efforts, great will be our gratitude." In a letter to his brother Jacob in 1691, Johann Bernoulli (1667 – 1748) wrote that "I see now the route for finding" $\zeta(2)$, but never published a result or a proof until after Euler had done so. Of course, we know that Leonard Euler (1707 – 1783) solved the problem. His solution came at age 27 after considerable background work. Euler's first contribution came in 1731 when he published a more efficient way to compute $\zeta(2)$. He found that

$$\zeta((2) = (\ln 2)^2 + \sum_{n=1}^{\infty} \frac{1}{n^2 2^n}.$$

This allowed him to approximate the sum to six decimal places, namely 1.644934. Two years later, he published what is now known as the Euler-Maclaurin formula and he used it to compute $\zeta(2)$ to a whopping 20 decimal places, but still no exact value. Finally, in 1734, he communicated that the exact value of $\zeta(2)$ is $\pi^2/6$ to his friend and sometimes-colleague Daniel Bernoulli (1700 – 1782), Johann's son. On hearing the solution, Johann Bernoulli, who had been a teacher of Euler, wrote, "If only my brother were alive!" Euler's first proof, which was based on the idea of factoring a polynomial in terms of its roots applied to an infinite series, was met with some doubt by Daniel Bernoulli and others, but it presaged the development of the theory of infinite products. In response to this doubt, he produced another proof that is accessible to our Calc II students. In fact, I have given a series (no pun intended) of exercises for the students that review many Calc II topics that are then used as lemmas for the Euler's proof. I complete the proof in class. (Unfortunately, this proof does not extend to other zeta values. If you are interested in seeing this proof, you can find it in Dunham's Euler, The Master of Us All.) Of course, Euler was not satisfied with computing $\zeta(2)$. His first proof also led him to the values of $\zeta(n)$ for $n = 4,\ 6,\ 8,\ 10$ and 12. For instance, $\zeta(4) = \pi^4/90$ and $zeta(6) = \pi^6/945$. By 1744, he had developed a formula involving the Bernoulli numbers that gives the zeta values for all even positive integers. Throughout his life he found many properties of the zeta function and his final work related to it was published in 1779 when Euler was 72 (and blind!) What he did seems to indicate that he never gave up hope of finding an exact value for $\zeta(3)$ and for other odd numbers. Euler's result for $\zeta(2n)$ showed that all the values were of the form $N\pi^{2n}$ where N is a rational number. It seems reasonable to expect that $\zeta(3)$ should have a similar form. Euler had developed a faster converging form for $\zeta(3)$ just as he had for $\zeta(2)$. By 1735, he had computed $\zeta(3)$ to 16 decimal places beginning with 1.20205690. . . , but no rational factor of π^3 was evident. Perhaps his earlier expression for $\zeta(2)$ was an inspiration, since he conjectured that $\zeta(3)$ was a function of π^3 and ln(2). He was able to sum a similar series, namely:

$$\sum_{n=0}^{\infty} \frac{(-1)^n}{(2n+1)^3} = 1 - \frac{1}{3^3} + \frac{1}{5^3} - \frac{1}{7^3} + \cdots = \frac{\pi^3}{32},$$

but this did not lead to $\zeta(3)$. Euler found other interesting relationships in his study of $\zeta(3)$. For example, in 1772, he proved that

$$\int_0^{\frac{\pi}{2}} x \ln(\sin(x))dx = \frac{7}{16}\zeta(3) - \frac{\pi^2}{8}\ln(2).$$

Three years later, he showed that if $h(n)$ is the n^{th} partial sum of the harmonic series, then

$$\zeta((3) = \frac{1}{2}\sum_{n=1}^{\infty} \frac{h(n)}{n^2}$$

In the nearly 240 years since Euler's death, no one has been successful in finding an exact expression for $\zeta(3)$. It was not until 1978 that Roger Apéry showed that $\zeta(3)$ is an irrational number. This has led many to call $\zeta(3)$

Apéry's constant. Unfortunately, his proof does not generalize, so no other odd zeta value has been shown to be irrational although it is known that an infinite number of them are irrational and that at least one of $\zeta(5)$, $\zeta(7)$, $\zeta(9)$, and $\zeta(11)$ must be irrational. Over the years, many alternative expressions for $\zeta(3)$ have been found including ones that allow rapid convergence and evaluations to many decimal places. The current record is over 1.2 trillion decimal places. (I recommend Nahin's book, In Pursuit of Zeta-3, where he discusses the history and gives proofs accessible to good calculus students of many of Euler's and more modern results.) I will finish with two thoughts. First, it is a simple exercise to show that

$$\zeta((3) = \int_0^1 \int_0^1 \int_0^1 \frac{1}{1-xyz} dxdydz.$$

So, if you could find a second way to evaluate the triple integral, you could be a famous mathematician! Finally, in 1859, Bernhard Riemann (1826 – 1856) extended the zeta function to complex numbers. It was Euler's work that opened the door for Riemann and his study of prime numbers. What the zeta function has to do with prime numbers has filled many books and will have to wait for another column.

We Need Better Online Math Education

Hal Huntsman, Antelope Valley College

I am deeply skeptical about online education, especially for community college math.

It's not for lack of trying. Starting around 2010, I saw the writing on the wall and in most of our class schedules: students wanted online education and they let us know by filling online courses almost as soon as they were opened for registration. Enrollment in most face-to-face sections lagged far behind. Administrators and some faculty asked for more and more online offerings.

Given these trends, and the promise that online education could make a college degree cheaper and more accessible, I felt that teachers had better be at the forefront of figuring out how to make it work for students and for learning. I applied for my college's online teaching course, was eventually admitted, and completed it. The next year, I started teaching online hybrid classes, which met in person, once per week, with the rest of the class time online.

I felt like a brand new teacher in the online environment. The training course taught me a lot, and trying to teach online taught me more. I read books and articles by folks with various levels of experience. I implemented new techniques and strategies in my online courses. Gradually, I felt I was improving.

In 2017, my sabbatical project tried to answer the question: *how can we best teach math to underrepresented students in an online or hybrid online setting?* The question turned out to be harder than I anticipated. It's not that I thought I would find "the answer" to how to teach math to students from underrepresented groups in an online environment. On the contrary, I expected to find a variety of possible approaches. Instead, I found no answers. None. As far as I could tell, no one was talking about the question I posed. I did find ideas about how to teach online and ideas about teaching underrepresented students. Sometimes these ideas were even focused on teaching math, but never all three at the same time. I did my best to bring those ideas together in my online courses when I returned from sabbatical.

Then, of course, the pandemic threw us all into the intense learning curve of teaching in an entirely virtual space. In the summer of 2020, I dove deeper into learning how to do online education better. I attended numerous workshops, read several books, and collaborated with colleagues. During the semesters in various modalities – synchronous online, asynchronous online, hyflex – I sought feedback and ideas from my students.

After more than a decade of studying and trying to implement math education online, I've learned that it's definitely possible to make online education better than it was in 2010 when my personal journey with online education started. Check out the work of Jesse Stommel, Michelle Pacansky-Brock, and others. We've made a lot of progress, much of which was turbocharged by the pandemic.

But, I've also learned that it's not good enough. I've known for many years that learning is social. We learn best when we say what we're thinking to other people (our teachers and our classmates) and have them question it and ask for clarification and put it another way. Especially in math, we need to watch as someone else tries to solve a problem and see where they succeed and where they do not. We need to offer ideas about how we might solve the problem. And we need to observe the body language and faces of our colleagues in this process. All these interactions serve to help us understand and retain ideas, to build connections and mental pathways.

Zoom, for all its glories, provides only a shadow of an approximation of the richness of these interactions. It does not enable students to work with each other in meaningful ways. Even if everyone has their cameras on, and students are using virtual white boards together, there is not enough information. We learn so much from the gestures, work, and sounds of the people around us, little or none of which we get in Zoom. This fact has only been reinforced to me by being back in the face-to-face classroom, watching my students interact with me and each other and learning so much more than they ever did online, even in my most engaged classes.

The situation is more acute in asynchronous classes, where students, by definition, may never directly interact with a teacher or a classmate in real time. Videos help a little, because they contain many of the in-person verbal and non-verbal cues. But they are interactive. In fact, my students tell me that they watch certain videos over and over again, trying to learn from them. And learn they do, but not all the things that they would have in-person. Our virtual math classrooms are mostly devoid of the social interactions that promote learning.

We need a much richer sensory experience for students and teachers in the virtual classroom, but either the technology doesn't yet exist, or it is prohibitively expensive. The research on online education confirms my skepticism and my observations: "Nearly every study comparing course completion rates between online and face-to-face community college courses has concluded that online completion rates are substantially lower. Evidence suggests that online learning may also negatively impact students' grades and undercut progression among community college students.

Poor online performance rates in community colleges are not simply due to the characteristics of students who choose to enroll in those courses. Challenges related to the online format—including technical difficulties, a sense of isolation, a relative lack of structure, and a general lack of support—may contribute to poor performance, particularly among community college students.

All this does not mean we need to scrap online math classes and offer only in-person options. The rabbit of online education is out of the hat, and we can't put it back. I think we, the teachers of mathematics, must be part of making online math education work for our students. I want to help make better technology and better online pedagogy. If you've had success teaching math online, please be in touch. Let's compare notes and share ideas. Our students and our colleges are counting on us.

Questions? Comments? Want to connect? Reach Hal at: shuntsman1@avc.edu.

Mentality, Mindset, and Math

Joshua Rhodes, College of San Mateo

The Fall semester has started and things are picking up from where we had left off. While I am still finding my way through what is, in many aspects, a different set of students compared to what I had when I began teaching (not very long ago, mind you!), I am taking note of what parts of instruction I am finding most useful to my students and myself. This semester has been particularly lucky for me as my course load is entirely courses that are entry level – There are no prerequisites required and they are all transferring and/or on track for STEM. So I have taken this semester as an opportunity to see what types of ideas, practices, and discussions land most effectively for my students in hopes of producing a group of successful learners (as we all do!).

Of course, due to AB 705, the entry level class has changed, but I do not wish for this piece to be about that legislation. This more to say that the students in entry level classes has changed and is much more broad. Coupling this with leaving pandemic lock-downs and going into face-to-face environments, I find myself with a genuinely new group of students. I think it is important to note, in terms of AB 705, that the courses I am teaching do not come with support, so my students did not choose to enroll in additional support courses alongside my own. This means that I have what is a (self-reported) new cohort of ready-to-begin-their-academic-journey students, which is exciting!

I ask my students, at the beginning of each semester, to write down what their main academic and life goals are (I let them interpret that themselves) on a sheet of paper, alongside other logistical things for me to know (what times they can do office hours and homework, if/when they work, etc.) for me to collect and keep throughout the semester. I usually use these to spark up conversations about why they are in school and try to frame their work in the class in terms of a bigger picture. I have done this regularly, but found it striking that, in this particular semester, many students did not have a clear picture of what their life goals were, or there was a disconnect between how their academic goals and life goals could align. It made for some very good conversation in the moments I got to speak with them, but also made me think about how these students view academics and mathematics more generally.

After the pandemic my students, through the obvious sample bias of being face-to-face, were excited to come back to on-campus courses as they had found that an online format could be distracting and not productive. I sympathize. However, I let them know that this means inherently that they will have to work harder than they did while away from campus. If things felt easier for them and/or they felt they learned nothing from the courses before mine, then it stands to reason that my course would be more difficult. I could see the discomfort in many students as the first few weeks progressed as my students began to get used to the more frequent check-in for homework, skills, and discussion. Some students stopped attending classes as regularly, and some students would intentionally sit away from others to dampen the odds that someone would speak to them about work in-class. However, these very same students began to fall behind. Some students were not equipped to deal with this new level of struggle that was being presented in our face-to-face environment. This does not mean that those struggling found it unproductive, and, as a few students had expressed during office hours, it was good they were getting used to things being hard again as it meant they were doing and learning more – I nearly wiped a tear away!

As I had eluded to in my last article, I am still struggling to find a balance between allowances for students who need it and sternness for students who, well, also need it. As an update on how that is going so far this semester, I have become much more attuned to finding when a student will need some allowances or guide-rails as well as those who need a more strict structure. On top of that, I have become much more comfortable talking to students about what they are finding difficult inside the course and out, as well as asking students why they have or have not done particular things (come to class, homework assignments, talk with group mates, etc.) which has alleviated a lot of stress about me pushing students too much or too far.

If anything, I have found that, for the students that I am fortunate enough to interact with regularly (they respond to emails and come to campus), I feel much more connected to. I feel more drive to try and help these students reach their academic goals and always like to bring up comments and ideas to them that would relate to their life goals. I feel closer to this type of student than I did before the pandemic, and I think a large part of it, at least for the face-to-face cohort, is coming from an absence of guided learning. Not just guided in course content and lecture time, but guided in a genuine and interactive manner that shows the student they are a person who is doing something immense, difficult, important, and productive towards the future they want for themselves. Things can still feel bleak for many of these students and having the mindset that they can, with work, make progress with someone who wants them to succeed can immensely increase their willingness to put in the time they need to learn the mathematics.

And to be quite honest, that is all that is really needed. If a student puts in the time to practice, discuss, and engage the ideas of their math class, they almost certainly will come to demonstrate competent understanding of the material. That is, was, and should always be the goal. We, as instructors, strive to make Mathematics not just a part of student's academic path, but a part of their lives. I get excited when a student relates something you are talking about to something in their own life, outside of class, on their own and I get to feel like that student now has the gift of seeing the world in a new, interesting (and better) mathematical way.

However, things are rarely so rosy. This outcome is, in a sense, a Platonic ideal that, if the student and I work hard enough, some projection of that ideal comes through and illuminates our minds for a while. What a gift! I strive for that feeling, but life so frequently finds ways to make it difficult to achieve.

As I said, all that is needed is students find the time and willingness to work on the concepts in a genuine manner. That is now a much bigger ask than before. We are a community college and our students vary in all measurable ways. Time is a luxury that many students cannot afford, some quite literally. It eats away at their opportunities to do homework, come to class, or discuss the topics with others. Some short on time will trade sleep for those goals, only to find that it cannot be sustained while learning. Others have instability in their lives, homes, hearts, or minds. This eats away at the willingness to work on concepts in a genuine manner. I absolutely understand why, when a student has some intense, heavy, worrisome, dreadful thing hanging over them, may not really get the nuances of the Rational Zero Theorem – They have more important things to worry about and I cannot blame them. This is a large part of why it is important for us to talk in a genuine and meaningful way with our students, so that we can understand what makes this journey of learning hard and how we can overcome it to get the educational goal we seek.

After having many discussions with my students, I will report that I've had a much greater success rate in terms of giving allowances to students and them returning the favor for more effort. Some students have had major issues come up, we communicate, I give a bit of leeway. As long as there is a mutual understanding that the deadline of a homework assignment isn't the same as demonstrating understanding by the end of semester or that coming to class only works if you are actually *there* physically and mentally, then it is fine to re-prioritize some things if you can make it up later and get back into the swing of things. A routine for students is important, but flexibility in that routine is critical.

While things are still going on, I have a feeling that this process of clear communication, while being mindful of learning goals, will pay off for these students. For the students that still do not manage to find a way to settle into success by the end of the semester, and whose efforts do not bear fruits in my classroom, I can at least take comfort in the fact that it just might in their next class, school, job, relationship, or struggle. And while that is not necessarily math, at least I can say that I am at least still teaching.

I will be glad to see where this semester's journey goes and update you all again. I would also love to hear what topics, in regards to discussing with students, you have had with your students and what impact you think it may have had in their mindset approaching your class. Let me know (and if you want to have it some of it shared as a follow up in our next newsletter) at rhodesj@smccd.edu

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