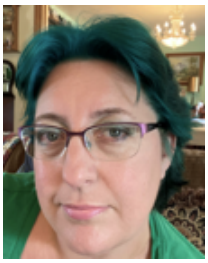
California Mathematics
Council Community Colleges

President's Report



Jen Carlin-Goldberg, Santa Rosa Junior College

Greetings my fellow Mathematics Enthusiasts! We have just completed our second fully online conference, and it was a fabulous affair. The talks were engaging and fun, and I learned so much from them. My deepest thanks to Larry Green, Katia Fuchs, and James Sullivan for doing the work to put this together.

If all goes well with our pandemic recovery, we have only one more online conference left to go! The Fall 2020 conference was fun and successful, and in true over-achiever style, we intend to make the Fall 2021 conference even better. That's a high bar to clear to be sure, but considering what CMC³ has been able to accomplish so far during this pandemic, I have the confidence that we can do it.

My thanks to Hyatt Regency for their help in making it possible to not hold a face-to-face conference again this year. Though their own projections showed that a face-to-face conference would be possible, it would not be the event that we would all want it to be.

This allows us to plan a comeback conference at the Hyatt Regency in Monterey for Fall 2022, our 50th fall conference! Even though it is a year and a half away, I am already excited about it. I hope I will see all of you there.

We have elections again this year. I remember our last election chair, Joe Conrad, saying that if you are unhappy with having all uncontested races, then run for something yourself! Good advice. If you have never held an office before, try running for an At Large position. We will find a set of duties for you that will suit your tastes and talents, and it is an excellent introduction to the CMC³ board. Many of our officers started out in that position, as I did. I began as the Adjunct Advocate and ran the Student Poster Contest. I was able to bring my own experience and ideas to these duties as well as rely on the experiences of those who did them before me. If holding any office seems too much right now, then you can also be a volunteer. There are plenty of jobs that you

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Executive Board & Special Committees

President: Jen Carlin-Goldberg, Santa Rosa Junior College (707) 527-4746, jcarlingoldberg@santarosa.edu

Past President: Katia Fuchs, City College of San Francisco, (415) 452-5395, efuchs@ccsf.edu

President-Elect: James Sullivan, Sierra College, (916) 660-7973, jsullivan@sierracollege.edu

Secretary: Tracey Jackson, Santa Rosa Junior College, tkkjackson@yahoo.com

Treasurer: Leslie Banta, Mendocino College, (707) 467-1053, lbanta@mendocino.edu

Members-at-Large:
Adjunct Advocate: Chantal Cimmiyotti, Mendocino College (707)467-1021, ccimmiyotti@mendocino.edu

AMATYC Liaison: Leslie Banta, Mendocino College, (707) 467-1053, lbanta@mendocino.edu

Articulation Breakfast: Steve Blasberg, West Valley College (408) 741-2564, steve_blasberg@westvalley.edu

Business Liaison: Dean Gooch, Santa Rosa Junior College, (707) 527-4704, dgooch@santarosa.edu

Campus Reps Coordinators: Leslie Banta, Mendocino College, (707) 467-1053, lbanta@mendocino.edu; Chantal Cimmiyotti, Mendocino College (707)467-1021, ccimmiyotti@mendocino.edu

CMC Liaison: James Sullivan, Sierra College, (916) 660-7973, jsullivan@sierracollege.edu

Conference AV Specialist: Steve Blasberg, West Valley College (408) 741-2564, steve_blasberg@westvalley.edu

Fall Conference Chair: James Sullivan, Sierra College, (916) 660-7973, jsullivan@sierracollege.edu

Foundation Board Member: Cortney Shultz, Santa Rosa Junior College, (707) 527-4705, cshultz@santarosa.edu; Manny Kang, San Jose City College, manjitkang@sjcc.edu

Foundation President: Katia Fuchs, City College of San Francisco, (415) 452-5395, efuchs@ccsf.edu

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Membership Chair: Kevin Brewer, Solano Community College, (707) 864-7000 ext. 4396, kevin.brewer@solano.edu

Monterey Speaker Chair: Wade Ellis, West Valley College (retired) (408) 374-0741, wade25@sbcglobal.net

Newsletter Editor: Jay Lehmann, College of San Mateo, (650) 863-5305, MathNerdJay@aol.com

Spring Conference Chair: Larry Green, Lake Tahoe Community College, (530) 541-4660 ext. 341, drlarrygreen@gmail.com

Student Poster Session: James Sullivan, Sierra College, (916) 660-7973, jsullivan@sierracollege.edu

Tahoe Speaker Chair: Katia Fuchs, City College of San Francsico, (415) 452-5395, efuchs@ccsf.edu

Web Page Coordinator: Darryl Allen, Solano Community College, (707) 864-7000 x7853, darryl.allen@solano.edu

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Call for Nominees

Please consider joining the CMC³ Board

Contact Past President Katia Fuchs if you are interested. (Look above for contact information.)

President's Report

(Continued from page 1)

can do to assist other board members.

It is also time for us to review and revise our organization's bylaws! I know, I am excited by the strangest things. Over the summer, a small committee will work on our bylaws, suggest some changes and additions that will help lead our organization into the future, fix minor errors, and clear up some confusions. We hope to have the revised bylaws ready for you to vote on this fall.

I attended the ASCCC Spring Plenary this year. Of the many resolutions that were debated and voted on, I was keenly interested in the resolutions involving open education resources (OER) and the Open Education Resources Initiative (OERI). I am the open education resources liaison for my own campus and several of our members have been longtime open education resource advocates, speaking about them at conferences for many years. Some of those resolutions are Resolution 11.02, which includes advocating for a data element so institutions would report on how many course sections have materials that are zero cost to students, as stipulated by SB 1359 (Block, 2016) and how many course sections have resources that are of low cost to students (low cost as locally defined), which was encouraged by Resolution 13.01 passed at the Fall 2017 Plenary. In addition, this data would be disaggregated; there will be separate categories for the different ways that course materials are zero cost to students. Materials that are paid for by a special program are not the same thing as free course materials such as OER. Another resolution was Resolution 9.05, which formerly codifies Anti-Racism, Diversity, Equity, and Inclusion in the OERI. Not only is quality OER one of the ways we address the inequity in education today, but the OER developed and highlighted by the OERI are some of the most diverse textbooks that I have ever used. I was struck a long time ago by the variety of names, genders, and examples used in the open education resources, such as the OpenStacks Algebra texts that I use today. Through OERI funding of California Community College faculty, we now have a Statistics for Social Justice resource available to use. I plan to integrate parts of this resource in my own statistics courses starting this fall. As I tell my students multiple times every semester, statistics and data analysis are powerful tools for the pursuit of social justice.

We continue the difficult work towards more diversity, equity and inclusion-focused policies, and procedures throughout the California Community College system. Mathematics, and STEM in general, needs to be part of shaping those policies. Our needs are specific and, in some ways, unique. Ideas that will work for other departments and divisions may not be ideal for us. As an institution, our goals are the same and we agree more than we disagree, but there must be room for a variety of solutions that work for different disciplines.

The CMC^3 Board work hard to find more diverse voices to speak at our conferences to help in this effort. The talks that you have given and the research and ideas that you have shared can help us all in this difficult but rewarding work. We will help each other find ways to tackle the problems in Community College Mathematics Education here in California. The CMC^3 Board is committed to this work and we hope you will consider running for a board position to join us in this work.

Math Nerd Musings: Rate My Professors

Jay Lehmann, Editor, College of San Mateo

We live in age of ratings. It's gotten to the point where it seems everything is rated: movies, restaurants, shoes, toaster ovens, and, yes, professors. It's hard to believe that at one time about the only thing that was rated was movies and a simple thumbs up or down would do.

With the wide variety of venues, products, and people getting rated, it's surprising that most ratings are almost uniformly based on a 5-point scale. It's been my casual impression that a typical average rating of a single product is about 4.0, rather than the middle rating, 3.0. For novels, I've found that average ratings on Amazon for a specific novel tend to be as follows: poor: 3.7, okay: 4.0, and great: at least 4.4.

Also by casual observation, it seems that a typical average rating on Rate My Professor (RMP) for a single math instructor is lower than 4.0, maybe 3.5. The variation of average ratings seems to be greater than for products, movies, etc.

I've discussed RMP with quite a number of instructors, who tend to think the ratings are meaningless. A typical complaint is that only the students who love or hate an instructor post ratings. Yet again, by casual observation, I've noticed that instructors tend to get more 1 and 5 individual ratings than 3, 4, and 5 ratings, but it's not extreme.

In a *nonrandom* sampling, I found that there is a negative, weak association between the difficulty rating and the overall rating (which does *not* include the difficulty rating).

There are certainly a host of sampling issues with RMP. But I think the feedback can still be useful. For example, even if more ratings come from strongly disgruntled and delighted students, certainly the *ratio* of the number of 5 ratings to the number of 1 ratings is meaningful. For another example, I find *some* of the written feedback to be detailed and helpful.

RMP can be an especially useful measure if an instructor makes a change in her or his teaching, especially if the instructor does not change the level of difficulty (although difficulty may be perceived differently by an instructor and students!). For example, about seven years ago I taught a path-to-stats course for the first time. To prepare, I attended a three-day CAP workshop, which included references to affective domain. This inspired me to reach out to students much more frequently and vigorously via e-mail when students missed class, didn't turn in assignments, were performing poorly on tests, and so on. I also encouraged students and talked to them more warmly during class. I soon made these changes for all my courses.

My rating on RMP captured this change. My most recent 20 ratings have an average that is 0.8 higher than my previous 83 ratings. That's quite a jump! (Strangely, some of the more recent ratings are not reflected in my overall average; I checked!)

I love variety. In my 31 years of teaching, I've used certain approaches for a number of years but then switched to other methods; this has kept teaching interesting to me and, hopefully, to my students. But the jump in my RMP rating has inspired me to continue to vigorously reach out to students for the rest of my career, which will be complete in 2.9 years.

CMC³ Fall Mathematics Conference Report

James Sullivan, President-Elect/Fall Conference Chair, Sierra College

The 49th Annual CMC³ Fall Mathematics Conference will be held virtually (via Zoom) on Friday, December 10, 2021 from 4:30 pm to 7:30 pm and Saturday, December 11, 2021 from 9:30 am to 2:15 pm. At the time this article was being written, the number of new COVID-19 cases and related deaths in California were decreasing and the number of available Coronavirus vaccination appointments were increasing, but at the time the fall conference committee began planning this year's conference, most California counties had reinstituted regional stay-at-home orders, and conference venues in Monterey County were not allowed to host events (in fact, they remain closed at the time of writing this article). In discussions with the Hyatt Regency Monterey Hotel, they offered to cancel our 2021 contract and extend it until 2023. The CMC³ Board voted to accept their proposal. As such, we are very much looking forward (as we hope you are too) to returning to an in-person conference in Monterey next year (December 2022) to celebrate our 50th Annual Fall Mathematics Conference.

Forgive my enthusiasm for looking forward to a future with the potential promise of returning to an onsite conference next year. Now, I must return my focus to the matter at hand. This report is intended to inform you about this year's online conference. We are planning to put on an informative and interesting conference this year that will be both relevant and engaging. Following the format of the virtual conference we organized last year, there will be nine breakout sessions and two keynote presentations. In between sessions, there will be breaks that offer opportunities for social interaction, problem solving, and information sharing.

Our Friday night keynote speaker is Beth Chance, Professor of Statistics at Cal Poly San Luis Obispo. Beth is an internationally renowned statistics educator, author, and the 2020 American Statistical Association Waller Distinguished Teaching Career Award recipient. She will share with us her valuable knowledge and vast experience teaching introductory statistics.

Our Saturday afternoon keynote speaker is Myra Snell, Mathematics Professor at Los Medanos College. Myra is a nationally recognized expert in remedial math reform and was named one of the "16 Most Innovative People in Higher Education" by the Washington Monthly. She is one of the co-founders of the California Acceleration Project (CAP) and has worked with Carnegie-Mellon's Open Learning Initiative in Statistics and consulted with the Statway Project of the Carnegie Foundation for Teaching. Myra's keynote presentation is titled "Faculty Mindset and Student Outcomes: What Does the Research Say?".

If you are interested in being a speaker at this fall's virtual conference, please go to the Fall Conference webpage on the CMC³ website and submit a proposal. We are especially interested in receiving proposals that present effective and equitable online assessment practices. If you were satisfied with the online assessments you implemented last semester but don't feel you can give an entire presentation on the topic, we still want to hear from you. We would like to be able to offer a panel discussion on online assessment practices where faculty can share their experiences with their colleagues.

We trust that you will find our 49th Annual Fall Mathematics Conference to be a useful and valuable professional development experience, and we encourage you to register for our conference when registration opens in the fall. Your support of CMC³ is greatly appreciated.

What's Happening at Taft College

David Mitchell

Hello everyone! There have been quite a few things going on at Taft College over the last year or so. As we transitioned to offering all of our classes online during the spring 2019 semester, we invested in a variety of resources in an effort to help our students

succeed during this difficult time. We received funding and worked with our library staff to provide laptops, hotspots, and calculators to our students free of charge over the last few semesters. This allowed many students to enroll in and successfully complete courses that they otherwise would not have been able to.

While there are no brand-new faculty members in our department (pretty typical since there are only seven of us), we are adding a few new courses. Our new college algebra course will be offered for the first time this fall, and we are developing a linear algebra course that we will be able to offer in the near future.

We are also very excited for the opening of our new Student Center building on campus, which will include our updated cafeteria, bookstore, student lounge, and other amenities for our students.

Our math department, along with our learning center on campus, has also worked to provide additional support for students taking math classes by offering free tutoring and comprehensive review sessions. These live review sessions, which are available to all students across campus, are held weekly via Zoom and are led by our math faculty. We advertise each other's review sessions across our Canvas courses to encourage as many students to attend as possible, which appears to be paying off, since we've had encouraging attendance and participation rates throughout.

These targeted review sessions tend to focus on topics that students are struggling with at various points throughout the semester. However, we also encourage students in higher-level courses to attend if they want a quick review of a certain topic. This has been especially helpful for students in our calculus series, as they've been able to attend a review session to brush up on their Calculus I topics. These sessions have included topics from courses ranging from intermediate algebra to statistics to differential equations. Students who have

attended our sessions have given plenty of positive feedback. Due to the success of these sessions, we are planning on continuing to offer these Zoom sessions in the future (even as we anticipate returning to a more face-to-face setting in the fall).

What's Happening at Yuba College

John Thoo

In response to AB 705, we made changes to placement measures as well as to courses, and started a Mathematics Teaching Community. Regarding placement measures, we generally kept with the state's recommendations for non-STEM majors, but were a little more strict for STEM majors. Regarding changes to our courses, we eliminated prealgebra, and now offer only a small number of sections of intermediate algebra and even fewer of elementary algebra. We increased the number of sections of elementary statistics and created a supplemental course that pairs with some of those sections. We also created a new one-semester course that is intermediate algebra with a review of elementary algebra. This course is intended for students who are interested in STEM, and it is offered in a lecture and lab format. Currently, we are creating a

supplemental course to help students beef up their algebra skills. This supplemental course will be attached to some sections of college algebra, trigonometry, and calculus for business, and social and life science. The Mathematics Teaching Community meets on Zoom twice a month to provide a venue for adjunct and full-time instructors to share their experiences, both foibles and successes, and strategies. Each meeting

centers around a particular topic such as exploring Canvas, classroom policies, favorite ice breaker activity, testing, cheating, and troubleshooting technology issues.

On the people side, our newest full-time faculty members are Mark Lydon and Dylan Noack from a couple of years ago. Both of them are Project Access fellows, although they are in different cohorts. This year Talwinder Chetra is on sabbatical to learn about teaching mathematics to future elementary school teachers.

We continue to look for a new home (a proper building with classrooms that are designed and outfitted to teach mathematics better). And we are looking forward to gathering together again after a year-plus of teaching not on campus. Apart from all that, the department continues to zoom along going about its business of serving students.

CMC³ Virtual Spring Recreational Math Conference Was a Success

Larry Green, Lake Tahoe Community College

Our first ever spring virtual recreational mathematics conference was as smooth and enlightening as we had hoped. We had a wonderful lineup of speakers and an outstanding group of attendees. It was noticeably clear that everyone is now an expert in Zoom and participating virtually.

The conference started out with Dr. Becky Moening presenting for Wiley publishing how adaptive learning can assist mathematics students in the learning process. This was followed by a team from Derivita who demonstrated their platform that assists students by creating quality homework, quizzes, and exams. On behalf of CMC³, I thank our publisher sponsors for their contributions that allowed us to offer this conference at no cost.

After these morning sessions, we had a welcoming time where we were able to get together at least virtually and greet each other. Then we were enlightened by Dr. Marion Campisi who spoke about how we can use mathematics to understand gerrymandering. This was particularly timely, since we are in the post 2020 census time which is when we as a country decide how to redistrict our congressional regions. Now let us hope our country will listen to mathematicians like Dr. Campisi so that we can have fair representation.

We were next fortunate to have Jessica Bernards and Wendy Fresh show us some examples of interactive mathematics learning activities that they have incorporated into their mathematics classes and showed us how these can be used in our classes to enliven the learning environment. After this wonderful presentation, we were entertained by master chef and mathematician Katia Fuchs as she taught us how to make yummy macaroni salad. Then we played some casino games to give us the feel of the Tahoe conference.

The closing talk of the conference was presented by Dr. Elena Fuchs who took us through the thousands of years of computing, starting with the ancient Greeks and brought us all the way to modern times. It was fascinating to hear about this journey from where everything had to be done by hand to today's era of computer based super-fast computing.

I sincerely give thanks to the CMC³ board. The success of the conference is very much due to all the work that the board put into this. Next year in the spring, unless another disaster happens, we will have the conference in person and will be able to be physically present to enjoy each other's company the old-fashioned way.

Update Your Calendar:

Fall VIRTUAL Conference

December 10-11, 2021

Serving on the CMC³ Board – What's in It for you?

Katia Fuchs, City College of San Francisco

As election season for the CMC³ Board continues to approach, I thought it would be pertinent to reflect on my service on the Board, and share some of the reasons that the decision to join the Board was probably the best in my career.

I joined the board as an At Large member in 2007, at the invitation of Susanna then Crawford, now Gunther. I was an adjunct faculty member then, the quintessential freeway flier, teaching all up and down Sacramento Valley. Susanna and I met because I taught at Solano College part time. This being 14 years ago I am a little fuzzy on the exact reasons she gave me to join, but I remember that she told me that everyone who is on the board is really nice, and that it was fun. These alone seemed like good enough reasons to take the plunge.

What I didn't realize at the time was that being on the CMC³ Board would throw me directly into the heart of all of the goings on of community college mathematics education in the state of California. I remember being a new Board member and attending meetings—held a few Saturdays a year at college campuses, sipping on coffee and chewing on a bagel (snacks are provided, which is pretty awesome), and listening to conversations about all the current events happening at colleges state-wide. Even though I was a young faculty member (I had only been teaching for two years at that time), I was learning about what my colleagues near and far were doing on their campuses. I was also learning about the pieces that were moving on the state level, and how those influenced community college mathematics and community college education more broadly. A lot of the discussions were over my head then—I just didn't have the experience to engage fully—but I soaked it all up like a sponge.

Three years later, I was fortunate enough to be hired full-time at City College of San Francisco—a job that to this day remains my dream job. While I do not know what factors ultimately contributed to me getting the offer, I felt more confident and more informed through the entire job-search process, both because of resources CMC³ offers our adjunct members, and because of my service on the Board.

I remember during one of my first years at CCSF, while I was still undergoing tenure review, I taught a Calculus III class, and was lucky enough to have several truly exceptional students. They seemed to be interested in mathematics beyond what was taught in the classroom—so I mentored each of them in creating a poster for the Monterey Conference Student Poster Session. I still remember all three poster topics: one was on catenary curves, one was on osculating circles, and one was on Haar wavelets. It was so awesome watching my students present their hard work. And it didn't hurt that one of them ended up winning, either!

In 2015, much to my surprise, I was nominated to serve as President-Elect of CMC³. I knew it would be a six-year commitment (the presidential cycle includes two years as President-Elect, two years as President, and two years a Past-President) but I had been involved for so long that I was honored and happy to accept.

The years that I served as president, 2018 and 2019, were the two most rewarding years of my career to date. Countless opportunities opened up to me: attending the AMATYC conference, working in collaboration with the

(See "Serving on the Board" on page 12)

AB 705 – Some Reasons to Celebrate and More Work to Do

Hal Huntsman, Antelope Valley College

Five years ago, if someone had told me that, in one year, we could increase the number of completions of transfer-level math in California community colleges by almost 50%, I would not have thought it possible. Yet, that is exactly what we have done.

According to data from the RP Group, the number of successful completions of transfer-level math at California community colleges for the Fall 2018 cohort was 46,938. Just one year later, that number was 69,131, an increase of 22,193 (about 47%). That means that for the Fall 2019 cohort, 22,193 more students completed their math requirements within two semesters (aka throughput) and are that much closer to completing their certificate, graduating, and transferring than the year before.

Disaggregated by race, the throughput rates for transfer-level math in the 2019 cohort all increased. African-American (34%) and Latinx (42%) students saw significant improvement, but our success with them still lags behind Asian (69%) and White (59%) students.

This happened largely because AB 705 forced us all to stop using invalid placement measures and to allow our students into the transfer-level courses that they deserve. They are college students, and they should be treated as such. No longer are they trapped in remedial sequences. And, though success rates in transfer-level math did decrease some (from 68% to 60%), this decrease is much less significant compared to the huge increase in the number of successful completions. When given the chance, most student rose to the

Table 4. Number and Percentage of Successful Completions of Transfer-Level English and Math Courses by Cohort—Fall 2015 to Fall 2019

Term	Successful Completions	Total Enrollments	Success Rate	Additional Successful Completions from Prior Fall Cohort
		English		
Fall 2015	56,046	72,788	77%	—
Fall 2016	62,638	81,441	77%	6,592
Fall 2017	73,764	96,582	76%	11,126
Fall 2018	93,918	125,423	75%	20,154
Fall 2019	120,021	172,367	70%	26,103
		Math		
Fall 2015	31,217	42,734	73%	—
Fall 2016	33,692	46,434	73%	2,475
Fall 2017	37,906	53,998	70%	4,214
Fall 2018	46,938	69,487	68%	9,032
Fall 2019	69,131	115,735	60%	22,193

Note: Success is defined as earned grade of A, B, C, CR, or P.

https://rpgroup.org/Portals/0/Documents/Projects/MultipleMeasures/AB705_Workshops/AccessEnrollmentSuccess_RPGroup_Final2020-1.pdf?ver=2021-01-06-082534-290

challenge and succeeded, showing they are more capable of learning at the transfer-level than we used to believe.

One critique of AB 705, based on these results, is to note the increase in the number of students who did not pass transfer-level math. In the 2018 cohort, 22,549 students did not complete transfer-level math within one year. In the 2019 cohort, that number increased to 46,604.

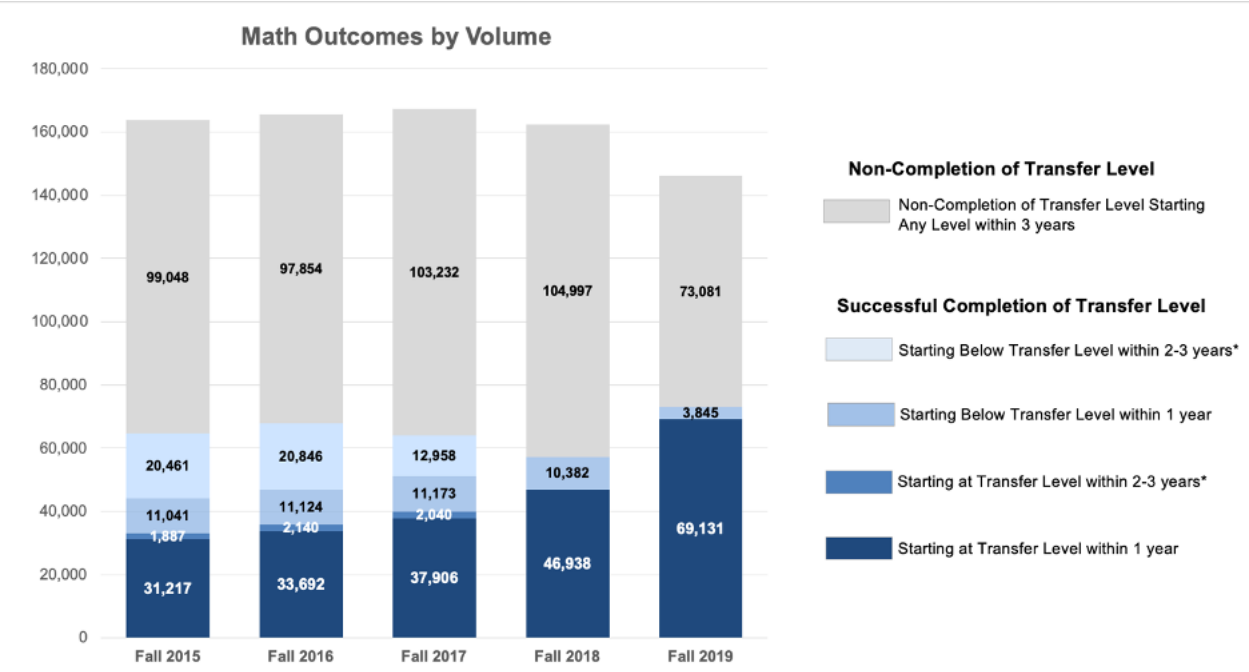
More than 46,000 students not passing transfer-level math is a serious concern. Along with the equity gaps we are still seeing, that number strongly calls for improved pedagogy and increased support for students in our courses.

At the same time, it's important to put that number in the context of the number of non-completers our system has had for many years. That is, as a system we have for many years had a huge number of students not completing transfer-level math. As we'll see, the number of students not completing transfer-level math has actually *decreased* significantly in the 2019 cohort.

Below, is a chart included in a presentation to our system's Board of Governors during their January 2021 meeting. According to these data, for the Fall 2015, Fall 2016, Fall 2017, and Fall 2018 cohorts, around 100,000 students did not complete transfer-level math. In Fall 2019, this number reduced to just over 73,000.

It is arguable, however, that comparing Fall 2021 to the Fall 2015, 2016, and 2017 cohorts is not fair, since the Fall 2019 cohort had only one year to amass non-completions. This argument would be a good one, but the Fall 2018 cohort data is also only for one year, so Fall 2018 data is entirely comparable to Fall 2019 data.

Focusing on the 2018 and 2019 cohorts, not only the did number of completions of transfer-level math increase by about 47%, but the number of non-completions decreased by about 30%. So, when we look at the effect of our community college system overall, AB 705 has improved the lives of our



*Fall 2015 and 2016: 3 years; Fall 2017: 2 years; Fall 2018 and 2019: 1 year. First attempt of course in the discipline.

students by allowing more students into classes they deserve to be in, dramatically increasing the number of students who have passed transfer-level math, and significantly decreasing the number of students who are not completing transfer-level math. This is a moment to celebrate a huge win for our system and for our students.

That said, as we (hopefully) emerge from the pandemic, there is still plenty of work to do. Even with the number of transfer-level math non-completers decreased significantly, we still need to do a better job supporting thousands of students, especially students of color, in transfer-level math. So far, the most successful models include some form of corequisite support (see this report from the Public Policy Institute of California: Access).

We are still in the early stages of understanding the impacts of AB 705. More than a year of remote learning has thrown us and our students into a whole new paradigm for understanding how to support our students as they learn the skills they need. Nevertheless, the first year of full-implementation of AB 705 is very encouraging. I look forward to seeing continued improvement as colleges and colleagues find more and more innovative ways to support our students.

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

Serving on the Board

(Continued from page 9)

State Academic Senate of the California Community Colleges, serving on a task force at the State Chancellor's Office, and meeting with state legislators, to name a few. Not only did my knowledge and understanding of California Community College education grow by leaps and bounds, but I had some of the most exciting professional experiences in my life.

Now my role on the CMC^3 Board is much less glamorous, but perhaps even more rewarding. As Past-President, I also serve as president of the CMC^3 Foundation, raising money for student scholarships and working to provide and support opportunities for students to develop a love for mathematics.

And so, in conclusion, I hope you too will consider serving on the Board. You don't have to know a lot to start, like I didn't in 2007. Come join an organization that is truly dedicated to making sure that mathematics educators and students in the State of California are thriving. If you're not sure if it's for you, come to our next meeting. All are welcome, and it's super fun!

The History Corner

Joe Conrad, Solano Community College

As I write this, we are nearing the end of spring semester which means that those of us teaching a precalculus course will soon try to get our students to understand mathematical induction. So, I thought I would dedicate this column to looking at the history of mathematical induction. In a nutshell, the concept of induction can be seen in some of the works as far back as the Greeks, but nothing is explicitly what we would call math induction until the late 1500's. The name "mathematical induction" would not appear until much later. I will not deal with the logical foundations of the method that were laid down in the late 1800's by Peano and others. That is another story!

First, I should clarify that by mathematical induction I mean the process by which we prove a statement is true for all natural numbers, possibly including 0, after a certain first value by proving it is true for the first value (the base step) and then, under the assumption it is true for n, proving it must be true for $n + 1$ (the induction step). It is the development of the concept of the induction step that I am using to decide what was math induction and what was not. Some see the basic idea of induction in the work of the Greeks, for example, Euclid's proof of the infinitude of primes. There are also shadows of the process in Hindu mathematics, for example, the cyclic method for solving certain equations by Bhaskara who died in 1185. None of these early thinkers used anything that resembles an induction step.

I should also note that Fermat is sometimes credited with using or even inventing math induction, but his method is really what we now refer to as infinite descent. He was not even the first to use that type of argument because Campanus of Navarro (c. 1220 – 1296) used it in his edition of Euclid's *Elements*. In fact, this argument can be seen even earlier in the so-called "paradox of the heap" credited to Eubulides in the fourth century BC. The paradox goes as follows: Suppose a heap has 10 million grains of sand. If we remove one grain of sand, we still have a heap. If we have a heap of 9,999,999 grains of sand and remove one grain of sand, we still have a heap. By continuing in this way, we eventually get a heap of one grain of sand.

Enough suspense, so who was the first to use mathematical induction in a way that we would recognize as such? This distinction goes to the Italian Francesco Maurolico (1494 – 1575). He lived and died in Messina to Greek parents who had fled Constantinople when the Ottomans invaded. As so many of the people of the time who made contributions to knowledge, he made them in many areas including astronomy, optics, music and he also translated many classical mathematics texts. Of course, we are concerned with his mathematics. He published what we call Euler's formula $V + E - F = 2$ in 1537 long before Euler did it in 1752. In fairness to Euler, I need to mention that Maurolico stated it only for the Platonic solids rather than Euler's far more general convex polyhedra.

In 1557 Maurolico wrote *Arithmeticorum libri duo* which was printed in 1575 in Venice. In this book, he made a study of natural numbers including even, odd, square and triangular numbers. Several of his proofs are applications of an argument by induction, but I want to call special attention to his

Proposition XV: "The sum of the first n odd integers is equal to the n^{th} square number." I think it is fitting that the first undeniable use of mathematical induction is to prove a statement that even elementary algebra students can discover and is a gem of the beauty of math! It is, of course, also one of the first examples we have our students prove with math induction in precalculus.

Maurolico states his argument much as we would. He goes beyond what we would do for the base step by looking at the first four steps. He then does the induction step by appealing to successive application of his Proposition XIII. Proposition XIII says that the n^{th} square number plus the $(n + 1)$st odd number equals the $(n + 1)$st square number. He has some other results which use induction, but this one clearly indicates a step n to step $n + 1$ progression.

Blaise Pascal (1623 – 1662) is the next person who actively used induction in the modern sense. He used it to prove results concerning what we call Pascal's Triangle. Pascal knew of Maurolico's work since he gave Maurolico credit for the proposition that twice the n^{th} triangular number minus n is n^2. This is equivalent to Proposition XI in Maurolico's *Arithmeticorum*. This shows that Pascal had seen Maurolico's argument by induction before doing it himself. We see that by the mid-1600's mathematical induction was being used by a well-known mathematician and was gradually used by more and more as time went.

Let's now explore the name "mathematical induction." In the time of Maurolico and Pascal most mathematics was done in Latin. With this understood, we will focus on what happened in English rather than what happened in other languages. Maurolico and Pascal did not have a name for what they did; they just did it. The first person who labeled the argument was John Wallis (1616 – 1703) who, in 1656, in *Arithmetica infinitorum* did a proof "*per modum inductionis*" which I think we can all translate. He uses similar wording elsewhere in the work. However, he does not actually do what we would call mathematical induction, but what a scientist would use, namely, he listed off many cases with increasing values of n and then states that this will continue indefinitely. Some refer to this as "incomplete induction."

What Wallis did led to much discussion among mathematicians as to its validity. Years later in 1685, in his *Treatise of Algebra* Wallis responds to one criticism by saying, "I look upon Induction as a very good method of Investigation; as that which doth very often lead us to the easy discovery of a General Rule." Finally, Jakob Bernoulli stated that Wallis's method of induction could be made rigorous by adding the n to $n + 1$ step. Having someone of Bernoulli's stature require the induction step ended the discussion!

For about a century and a half after Bernoulli the word "induction" was used to mean both incomplete induction and mathematical induction. In fact, it was used more for incomplete induction than mathematical induction which was still often used without a name. Among those who used it without a name were Thomas Simpson (1710 – 1761) and, much later, George Boole (1815 – 1864). The first English writer to give it a name was George Peacock (1791 – 1858) who called it "demonstrative induction" in his *Treatise on Algebra* in 1830.

By virtue of the fame of the author, possibly the most important publication for establishing the name "mathematical induction" was written by Augustus de Morgan (1806 – 1871). He published the article "*Induction (Mathematics)*" in 1838 where he suggests the new name "successive induction", but by the end of the article refers to it as "mathematical induction." Isaac Todhunter (1820 – 1884) popularized both names in his algebra text from 1866, but the section devoted to the topic was labeled "Mathematical Induction." This led to textbook authors using "mathematical induction" up to the present time. This included American authors who early on did not use a name, but by the 1880's had settled on "mathematical induction." The first American author to use it was Joseph Ficklin (1851 – 1908) at the University of Missouri in his textbook *Complete Algebra* from 1874. More textbooks followed suit and by 1900 other names had virtually disappeared in the US. The last competitor was "complete induction" which continued to be used by some into the 1900s.

I hope you have a great day today and that any day you have a great day, it guarantees that the next day will be great as well!

What's Happening at Merritt College

Sun Young

The Merritt College classes were conducted in the traditional face-to-face method of instruction before the spread of the virus and the imposition of lockdowns. As a consequence, learning and testing have moved almost entirely to online learning. One year later, faculty and students are well acquainted with the online educational tools and the new status quo. Yet, the lack of resources made going remote more challenging for students, teachers, and even school administration.

Some students did not have access to a laptop or the software for it, and others did not even have stable WiFi. Thus, our Math and Physical Science Department at Merritt College ensures that equity is included in program learning plans, goals, and activities, including a Chromebook loan program, a math lab, and professional development for both instructors and students to complete the course successfully. In order to support disadvantaged students in online courses, the department provided free Opening Learning Resources (OER) material on Canvas, which is a zero-cost resource for students in need.

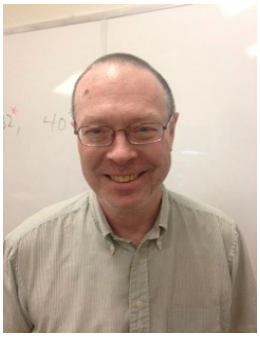
Lastly, the department encouraged all faculty to utilize professional development funds that helped faculty to improve their teaching practices such as active learning, equitable teaching strategies, and assessment to shape their class into a strong, positive, and equitable learning environment.

Except for limited hybrid and face-to-face offerings in the next fall 2021 semester, all math courses will be 100% online. Our department expects to close the equity gap in STEM courses among disadvantaged minority students with our ongoing efforts and plans in the upcoming academic year.

The Pleasures of Problems

Kevin Olwell, San Joaquin Delta

Summer 2021: Square $ABCD$ has sides of length L. Centered at each vertex is a circle of radius L. The four quarter circles inside $ABCD$ intersect in a region $\mathscr{R}$ that looks like a "square with round sides". What is the area of $\mathscr{R}$?



Spring 2021: How many 16-digit strings of 0's and 1's are there which do not have two 0's next to each other?

Thanks to Fred Teti, Chuck Barnett and Brad Krein for submitting a solution.

Fans of the Fibonacci sequence, your day has come! Let S_n be the number of n-strings that do not have consecutive 0's and let $S_{n,i}$ denote the number of such strings ending in $i = 0, 1$. Then

$$S_n = S_{n,0} + S_{n,1}. \tag{1}$$

Notice that appending a 1 to the end of any string in S_{n-1} gives a string in $S_{n,1}$. Thus

$$S_{n,1} = S_{n-1}. \tag{2}$$

Next, deleting the final 0 from a string in $S_{n,0}$ produces a string in $S_{(n-1),1}$. From equation (2) we obtain

$$S_{n,0} = S_{(n-1),1} = S_{n-2}. \tag{3}$$

Substitute equations (2) and (3) into (1):

$$S_n = S_{n-1} + S_{n-2}.$$

In other words, the sequence $S_1, S_2, S_3, \ldots$ satisfies the same recursion relation as the Fibonacci sequence. Since $S_1 = 2 = F_3$ and $S_2 = 3 = F_4$, we get $S_{16} = F_{18} = 2584$.

Chuck Barnett gave a useful alternative: count the n-strings with no zeros, those with 1 zero, with 2 zeros, and so on. The payoff for counting S_n this way is a pretty relationship between the binomial coefficients and the Fibonacci numbers. The tricky part is counting how many n-strings have k zeros. For example, one way to count the number of strings with 6 zeros and 10 ones starts with the following string alternating 11 zeros with 10 ones:

$$(0,1,0,1,\ldots,1,0). \tag{4}$$

Choose any 6 zeros to keep; deleting the other 5 yields a (6-zero, 10-one) string. An n-string with k zeros will have $(n-k)$ ones. The string in (4) will alternate $(n-k+1)$ zeros with the ones. Hence the number of n-strings with k zeros is

$$\binom{n+1-k}{k}.$$

Since the binomial coefficient is zero once $k > n+1-k$, we need not specify the upper limit for k in the following sum:

$$F_{n+2} = \sum_{k=0} \binom{n+1-k}{k}.$$

Submit a solution to the current problem to: kevin.olwell@icloud.com

CMC³ Foundation Report

Ekaterina Fuchs, City College of San Francisco

Although the uncertainty of the times we find ourselves in made it impossible to hold the Tahoe Conference in person this April, the Virtual Spring Conference we held instead was a resounding success, if I do say so myself. Thank you to our speakers, our sponsors, and most importantly, you—our guests! I am so grateful for your continued support, and I am glad you were able to attend our conference virtually and get something positive from it. I am additionally thankful that your donations at the conference and throughout the year made it possible for us to continue our annual student scholarships.

Special thanks go to those of you who nominated a student for a scholarship this year – it has been a terribly difficult year, and I am so impressed that so many of you were able to carve out the time between adjusting to teaching remotely and working from home and dealing with the stresses of a global pandemic to mentor some of our excellent students.

We were pleased to be able to award four $1500 scholarships to Richard Lo from City College of San Francisco, Talia Saarinen from Santa Rosa Junior College, Brianne Parmer from Modesto Junior College, and Alexander Renteria from Mendocino College.

Brianne hopes to use her skills in biomedical engineering to start a global movement making even the most cutting-edge medical devices available to every corner of our globe, no matter how remote.

Alexander is interested in game theory and data science, and has been loving the study of mathematics since the first grade!

Richard Lo has returned to community college after finishing his Bachelor's degree at UC Davis to pursue his true passion of becoming a community college mathematics instructor.

Talia's vast interests in mathematics, astronomy, and physics led her to take a class in graph theory at Sonoma State University!

Our students make up the true heart of everything we do, and it is such an incredible privilege to be able to support them on their educational journey.

If you are interested in donating to the Foundation but have not yet had a chance to do so, it is never too late! Click here to go to our donations page; there are multiple ways to contribute, from making CMC³ Foundation your charity of choice on Amazon Smile, to a one-time check or PayPal donation, to monthly donations through PayPal. Your financial support allows us to continue providing student scholarships to well-deserving community college students.

Calendar

Visit the CMC website (https://www.cmc-math.org/conference-overview) for current information and details about their upcoming conferences.

August 4—7, 2021: MAA MathFest, Sacramento, CA. Website: https://www.maa.org/meetings/mathfest

September 25, 2021: WisMATYC Annual Conference/Meeting, Racine, WI. Contact: Jason Gerber, gerberj@gtc.edu.

September 22—25, 2021: NCTCM Annual Meeting and Exposition, Atlanta, GA. Website: https://www.nctm.org/atlanta2021/

October 22—23, 2021: VMATYC Statewide Conference, Virginia Western Community College. Contact: Theresa Thomas, thomast@brcc.edu.

October 28—31, 2021: 47th AMATYC Annual Conference, Phoenix, AZ. Contact: Turi Suski, suski@fvtc.edu

December 10—11, 2021: CMC³ 49th Annual Fall Conference, REMOTE. Contact James Sullivan, Sierra College, (916) 660-7973, jsullivan@sierracollege.edu

Jay Lehmann
Editor
CMC³ Newsletter
MathNerdJay@aol.com