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50th Annual
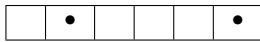# Washington College
Mathematics Conference

Yakima Convention Center
May 17–19, 2018

Hosted by the Edmonds Community College Mathematics Department

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SCHEDULE

Thursday, May 17

5:30–7:00 p.m.	Department Chair Meeting	B
7:30–9:00 p.m.	Opening Session	D
9:00–10:30 p.m.	Crowdsourced Data Collection	E

Friday, May 18

7:00–8:30 a.m.	Breakfast	D
8:50–9:40 a.m.	Session I	A B F G H
9:55–10:45 a.m.	Session II	A B F G H
11:00–11:50 a.m.	Session III	A B F G H
12:00–1:15 p.m.	Lunch	D
1:30–2:20 p.m.	Session IV	A B F G H
2:35–3:25 p.m.	Session V	A B F G H
3:30–4:30 p.m.	WAMATYC Membership Meeting	G
3:30–6:00 p.m.	Applied Probability & Pseudorandom Walks	H / L
6:15–8:15 p.m.	Dinner & Keynote Address	D
8:30–10:30 p.m.	Musico-kinesthetic Recreation	E
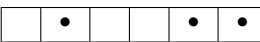
Saturday, May 19

7:00–8:00 a.m.	50 hm Estimation Run/Walk	L
7:30–9:00 a.m.	Breakfast	D
9:30–10:20 a.m.	Session VI	A B F G H
10:40–11:30 a.m.	Session VII	A B F G H
11:31 a.m.	Conference Ends	L

Your nametag is your meal ticket. Please return nametag holders and unwanted book bags to the registration desk before departure.

ONLINE RESOURCES

For electronic access to session handouts and links (and more!), enroll in WAMAP course **14626** (no enrollment key required). If you are not already a WAMAP user (or to access the WAMAP material without logging in) follow the instructions on the conference Web site: `www.wamath.org`

CONFERENCE HISTORY & FUTURE
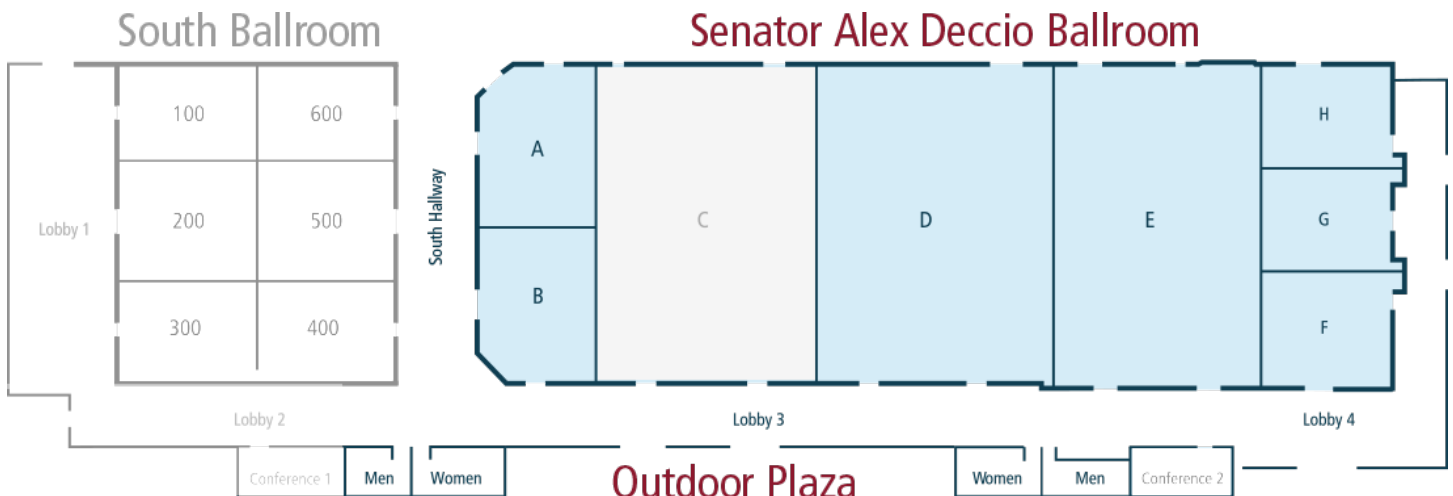
1969	Green River + Highline + Ft. Steilacoom	1995	Skagit Valley + Whatcom
1970	Spokane Falls	1996	Spokane Falls + ORMATYC
1971	Everett	1997	Green River
1972	Everett	1998	Tacoma + Big Bend
1973	Seattle Central	1999	Edmonds
1974	Green River	2000	Bellevue
1975	Highline	2001	Peninsula + ORMATYC
1976	Bellevue	2002	Clark
1977	Shoreline	2003	Spokane + North Idaho
1978	Edmonds	2004	Pierce
1979	Olympic	2005	Highline
1980	Spokane Falls	2006	Olympic + ORMATYC
1981	Spokane Falls	2007	Wenatchee
1982	Highline	2008	North Seattle
1983	Olympic	2009	Columbia Basin
1984	Green River	2010	Yakima
1985	Shoreline	2011	Green River + ORMATYC
1986	North Seattle	2012	Tacoma
1987	Lower Columbia	2013	Whatcom
1988	Olympic	2014	Everett + Shoreline
1989	Bellevue	2015	Bellevue
1990	Clark	2016	Clark + ORMATYC
1991	Pierce + Tacoma	2017	Highline
1992	Yakima	2018	Edmonds
1993	Highline	2019	Centralia + Bates
1994	South Seattle	2020	Pierce
		2021	Clark + ORMATYC

More information and 25-plus years of conference programs available at: `www.wamath.org/about`

Yakima Convention Center WiFi password: **meetings**

L = Lobby

South Ballroom — Lobby 1, Lobby 2, 100, 600, 200, 500, 300, 400, Conference 1, Men, Women

South Hallway

Senator Alex Deccio Ballroom — A, B, C, D, E, F, G, H, Lobby 3, Lobby 4, Women, Men, Conference 2

Outdoor Plaza

DIVERSIONS

Crowdsourced Data Collection

After Thursday's talk, engage your fellow mathematicians in conversation and gather information using the data-collection form found inside this program. Forms are due at the registration table by 1:30 p.m. Friday to be eligible for prize(s).

Challenge Problems

Participants are on the honor system not to use Google or other resources. Submit solutions (showing all work) to the registration desk no later than 6:30 p.m. Friday. High scorers will be announced during breakfast on Saturday. Decisions made by the judge(s) are final.

1. Compute $\dfrac{W}{A}$ if $W = \int_0^1 \left(1 - x^{50}\right)^{100} dx$ and $A = \int_0^1 \left(1 - x^{50}\right)^{101} dx$.

2. Compute $\displaystyle\prod_{k=1}^{2018} \cos(k\theta)$ if $\theta = \dfrac{2\pi}{2018}$.

3. The first quadrant contains three regions of finite area bounded by the line $y = c$ and the curve $y = 2018x - 50x^3$. Find the value of c for which the region bounded by the y-axis and the region bounded below by the line have equal area.

4. A mathematician saves her name badges from each of 50 math conferences she has attended. If she randomly selects 18 of the badges (with replacement), what is the expected value of the number of distinct badges she selects?

5. Eighteen mathematicians arrive at a conference having failed to register in advance and agree to eat whatever the kitchen serves them for dinner. If there is enough extra food to make 50 salmon, 17 chicken, 6 lasagna and 4 meatless meatloaf dinners, how many distinct sets of 18 extra meals can the chef prepare?

6. Divide 50 liters of water evenly between containers A and B. Pour half the contents of B into A, then pour half the remaining contents of B into A, and finally pour half the contents of A into B. Repeat this BBA pattern ad infinitum. What is the limiting value of the amount of water in B? What if the initial amounts of water in A and B are unequal?

7. Compute $\dfrac{I}{J}$ if $I = \int_0^{50\pi} e^t \left[\cos^{2018}(t) + \sin^{2018}(t)\right] dt$ and $J = \int_0^{\pi} e^t \left[\cos^{2018}(t) + \sin^{2018}(t)\right] dt$.

8. Randomly select α from $\{1, 2, 3, \ldots, 10\}$, β from $\{1, 2, 3, \ldots, 20\}$, γ from $\{1, 2, 3, \ldots, 30\}$, δ from $\{1, 2, 3, \ldots, 40\}$ and ϵ from $\{1, 2, 3, \ldots, 50\}$. Compute the probability that $\alpha < \beta < \gamma < \delta < \epsilon$.

9. During the first 50 minutes of May 18, 2018, for how long are the hour, minute and second hands of a 12-hour analog clock all on the same side of some diameter of that clock, assuming that the hands all move continuously?

10. If $\pi(x)$ is a polynomial of degree $d \leq 2018$ with $\pi(0) \cdot \pi(1) \cdot \pi(-1) \neq 0$ and $\dfrac{d^{2018}}{dx^{2018}} \left[\dfrac{\pi(x)}{x^3 - x}\right] = \dfrac{\varphi(x)}{\gamma(x)}$ where $\varphi(x)$ and $\gamma(x)$ are polynomials, find the minimal degree of $\varphi(x)$.

Applied Probability: Games

At 3:30 p.m. Friday, following Mike Kenyon's "Play More Games!" talk, join a game-playing session in Ballroom H.

Pseudorandom Walks: Tours of Yakima Tasting Rooms

Yakima Valley is the hops capital of the United States and one of Washington's finest wine regions. Knewton is providing transportation for a tour of Bale Breaker Brewing Co. from 4:00 to 6:00 p.m. on Friday; sign up at the registration desk. Or join colleagues on a self-guided tour of the wine-tasting rooms just a short walk from the Convention Center; pick up a map at the registration desk. As with all conferences, we ask that you confer responsibly. Please return in time for dinner.

Musico-kinesthetic Recreation: Dance the Night Away

After Friday's keynote talk, Ballroom E will feature music (provided by Pristine Entertainment) and dancing until 10:30 p.m. Put on your dancing shoes, grab a partner and cut a rug, or just enjoy the music. A no-host bar will add to the ambience.

50 hm Estimation Run/Walk

Before breakfast on Saturday, enjoy some exercise with a 50-hectometer ($= 5$ km) group run/walk. Meet in the Red Lion lobby by 6:55 a.m. and record a prediction of how long it will take you to run or walk (or skip or jog) the course: no watches, phones, Garmins or other timekeepers allowed! Information sheets are available at the registration desk.

ABSTRACTS

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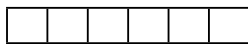
Opening Session   Thursday 7:30–9:00 p.m.

Finding Patterns: Art and Math   D
Luke Rawlings • Bellevue College

Presenting his original artwork, Luke Rawlings will explore ties to mathematics and mathematics education, while discussing the challenging work required to produce a dissertation involving regular division of the plane (inspired by M.C. Escher) and its relationship to abstract algebra. The talk will also reveal how he created these works of art using principles of symmetry, the different symmetries one can find in art, and examples of how art can be used to illuminate some of the mathematics one might encounter in a course on abstract algebra.

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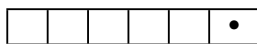
Session I   Friday 8:50–9:40 a.m.

Pre-college Mathematics Reform: A Status Update   A
John Mitchell • Clark College

Clark College is currently restructuring and simplifying its pre-college offerings, aiming for a higher proportion of students to successfully complete college-level courses within their first year. We are implementing a two-quarter applied algebra sequence to better serve those destined for less technical college-level courses, along with "co-requisite remediation" of targeted pre-college topics in college-level STEM and business courses. We overview the course structure and its motivation, outline how we are addressing teacher training, advising and other project impacts, and discuss what we have learned so far — as well as the challenges that lie ahead. There will also be some time for group discussion and reflection, so participants can share pathways ideas and best practices.

Accessibility in WAMAP   B
David Lippman • Pierce College Ft. Steilacoom

Ensuring the accessibility of our course materials is an essential responsibility for us all. This talk will explore the built-in accessibility features of WAMAP, and discuss best practices and techniques for ensuring the accessibility of content and questions.

Flippin' Statistics   F
Tyler Wallace • Big Bend Community College

Flipping the classroom provides many benefits, including extra time to focus on conceptual understanding rather than just procedural fluency. This talk will examine a flipped statistics course and some example activities used to reinforce conceptual understanding of topics students typically struggle to understand (even if they can correctly calculate the answer), along with an open-source textbook that provides many flipped activities (although this will not be the focus of the talk).

A Short History of Mathematical Notation and Symbols   G
Rajesh Lal • Pierce College

How is our mathematical thinking different from that of our ancestors? What is the difference between mathematical symbol and mathematical notation? How do symbols take us beyond what they are meant to represent? Why do we use the letter x so much in math? What are the pedagogical implications? This workshop will intersperse short presentations with activities and discussion.

Game On! Using Play to Engage Students in Pre-college Courses   H
Leslie Glen • Whatcom Community College

If students encounter the same content delivered the same way as when they failed a high-school course, they are unlikely to believe they will fare any better. Research on mindset shows how easy it is to change your mind about your ability to accomplish a task, but what can prompt us to make that change? By using games designed specifically to convey mathematical concepts, we can engage students in ways that may not have seemed possible to them before. Well-designed games are level-playing-field starting points, and the space in which they are played is safe and happy. We will discuss mindset, what is meant by a "well-designed" game, and how to go about creating one.

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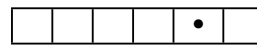
Session II   Friday 9:55–10:45 a.m.

Continuity and Context in Statistics   A
Allen Mauney • South Puget Sound Community College

Statistics textbooks (and courses) generally move from topic to topic without providing a thread linking the subjects into a coherent whole. There is little evidence in the texts that all of these methods and techniques could be used to address questions about a single topic or data set. Professionals use the approach: Here is a task and here are my tools — which of these (maybe all!) can I use to understand what's going on? I have extended work in a *Mathematics Teacher* paper (and continued by Mario Triola in several of his texts) investigating gender/age discrimination at the Oscars. Students apply each new method to better understand the data, reflecting on the relative value and strength of graphical, probabilistic and inferential techniques to understand problems and make decisions.

Math in Motion: A Learning Community Integrating Physics and Calculus!   B
Jonathan Ursin & Danielle Mallare-Dani
Seattle Central College

We will present our experiences co-teaching a learning community integrating physics and calculus, discussing benefits and challenges, and sharing example assignments, schedules and student feedback, while discussing logistics in the creation of the courses.

The High School Math Assessment and Bridge to College Math [F]

Megan Luce • Cascadia College | Bill Moore • SBCTC

The "July surprise" legislation of last summer moved the Smarter Balanced Assessment of college readiness from 11th grade to 10th grade. This session will explore how this shift might impact the system-wide placement agreement as well as future directions for the Bridge to College Math course that is currently being taught in over 100 Washington school districts. Come provide your perspectives on how to address these changes and help prepare high-school students to succeed in college-level math!

The Mathematics of Musical Tuning and Temperament [G]

Eric Mack • North Idaho College

I have created and teach an interdisciplinary class titled "The Mathematics and Aesthetics of Musical Tuning." At the heart of this topic is the impossibility of obtaining an integer solution to the equation $2^x = 3^x$, two being the ratio between frequencies that our human ears hear as octaves and three the ratio of frequencies we hear as perfect 12ths. In this presentation we will explore the nature of the conundrum, some of its many imperfect solutions, the philosophy behind them, and the art they have given rise to over the millennia. Computer programs will make the math audible, bringing this ancient quadrivium subject to life.

Liven Up Your Class With Kahoot! [H]

Pam Lippert & Deanna Li • North Seattle College

Want an exciting first day of class? Want a quick way to check your students' understanding? Tired of paper-and-pencil or online test reviews? Kahoot! may be the answer. Learn how you can make your own Kahoot! and see how we have used it with our classes. For the ultimate experience, bring a smartphone, tablet or laptop.
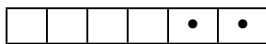
Session III — Friday 11:00–11:50 a.m.

WAMATYC Invited Session in Mathematics: The Algebra of Technology [A]

Olga Shatunova • University of Washington Tacoma

Boolean algebra is credited with laying the foundation for the information age. In my talk I will discuss Boolean algebra (which is particularly important to computer science and abstract mathematics) and how it is utilized in technology, computer design and the theory of switches. I will discuss Boolean algebra as an example of an algebraic system, laws of thought, its operations and its many applications. Students get excited when they see how computers and other technology work based on Boolean algebra. As time allows, we will see how to create components for computing.

Implementing Math Pathways: Bringing Departments Together Through Professional Development [B]

Alys Hugo & Mike Story • Everett Community College

Everett Community College recently redesigned its developmental math sequence in accordance with Guided Pathways, removing some traditional algebra topics for non-STEM students to allow greater focus on conceptual understanding and problem-solving. Everett's efforts are unusual in that the mathematics department has been working closely with Transitional Studies (previously Adult Basic Education) to ensure student success across the widest-possible demographic while providing significant professional development to faculty. We'll address the mechanics of our redesign from conception through implementation and the challenges and rewards of our cross-campus collaboration, providing feedback from instructors, sharing data on student success, and exploring a history as told by flowcharts.

Vorticity in Basic Multivariable Calculus [F]

Yves Nievergelt • Eastern Washington University

Increasingly, engineers and scientists are talking about topological insulators. What they call the "vorticity" of a nonvanishing planar vector field is not its curl but its "degree." The degree is continuous, but (unlike the curl) it is an integer. Therefore the degree does not change if conditions are slightly perturbed, so it might be used to store information—this is why people are interested in it. This talk will show how to introduce and practice vorticity in basic multivariable calculus without adding any new material, merely by replacing old examples, exercises and homework problems with new ones at the same level.

### Get Your Students Involved, Thinking, and Talking Math [G]

Nancy Marx • Edmonds Community College

In this interactive, hands-on session, I will demonstrate various simple methods to increase students' engagement with each other and mathematics. These strategies increase students' retention and comprehension and make the mathematics classroom a more productive space. These easy-to-use activities work for every level of class.

Dollar Street: A New Kind of Data With Many Possibilities [H]

Rejoice Mudzimiri & Robin Angotti
University of Washington Bothell

Immigrant students bring rich, diverse cultural backgrounds to mathematics classrooms that can enrich those classrooms using Dollar Street, an online photo and data resource that imagines the world as a street ordered by income. On Dollar Street, the poorest live to the left and the richest to the right, while everybody else lives somewhere in between. This session will introduce participants to Dollar Street and explore some mathematics activities that incorporate Dollar Street data.
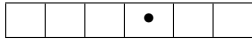
Session IV   Friday 1:30–2:20 p.m.

Graphing Without a Calculator   [A]
William Webber • Whatcom Community College

In this era of readily accessible graphing utilities, I find myself wondering if students even know how to graph a function without technology. In fact, graphing calculators have been around long enough that I wonder how much teachers even know about drawing graphs of functions and equations. In this presentation I will look at a range of graphing techniques from beginner to advanced. We will end by discussing how the ability to draw graphs leads to the more applicable skill of mathematical modeling.

The Transfer-Student Experience: [B]
Smoothing the Transition
Erik Tou, Haley Skipper, Brian Heaven &
Shubha Rajopadhye • University of Washington Tacoma

Students who begin their post-secondary career at a Washington community college often face unique challenges when they transition to a four-year school. This roundtable will consider two broad themes: curriculum and communication. Our goal is to identify good curricular choices for both two-year and four-year institutions that can smooth the transition for students, along with best practices for communication that will promote student success.

Back to Basics: Outcomes From Redesigning   [F]
Basic Math Course Sequences
Ryan Orr & Rebecca Luttrell • Columbia Basin College

During Fall 2015, with funding from a Title V grant, Columbia Basin College began pilot courses implementing redesigned instructional delivery methods to students in the first two classes of the developmental-math course sequence. We will discuss the redesigns implemented, lessons learned, changes made and the current state of these courses, along with student-outcome data, future plans and redesign at other levels, and encourage a discussion between other faculty or colleges who may be considering a redesign of their developmental-math courses.

An Accelerated Math Literacy Pathway via I-BEST   [G]
Christopher Cary • Spokane Falls Community College

Learn how we created an academic I-BEST program that provides a cohort of students on the math literacy pathway the opportunity to complete developmental and college-level math in one quarter. Journey over hurdles and through hoops, with stops in Placement Land, Advising Town, Registarville and the trendy suburb of OER.

Puzzle Morsels   [H]
Murali Krishna • Clark College

I have been perusing the excellent MAA book *More Mathematical Morsels* by the late Canadian mathematician Ross Honsberger (1929–2016) and selected some very entertaining puzzles from this book and other sources. These are not trivial to solve but have short and very elegant answers. I will present as many of these as possible in the time allotted.

To access the puzzle problems prior to the talk, visit the WAMAP classroom associated with the conference (see inside the front cover of this program for details).
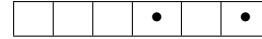
Session V   Friday 2:35–3:25 p.m.

A Collaborative Journey: [A]
Virtual Manipulatives for Mathematics
Frank Marfai • Phoenix College
William Meacham • Scottsdale Community College

Mathematics Virtual Manipulatives, an interactive OER resource to support student learning in developmental mathematics, resulted from a collaborative effort between faculty at two of the Maricopa Community Colleges. This resource transforms the way we can teach mathematics, allowing students to move virtual objects through a touchscreen or iPad, and introducing efficiencies and opportunities not available with physical manipulatives (student responses to these manipulatives can be assessed through WAMAP). The virtual manipulatives give concrete representations to concepts students originally found abstract (which forced them to memorize rules without understanding why they work). Students experience firsthand why the sum of two negative numbers is negative but their product is positive, and why $\frac{1}{4} + \frac{1}{3} = \frac{7}{12}$ (not $\frac{2}{7}$). Seeing students overcoming their fear of math through these successful experiences is motivating and inspiring.

Transitioning Learners to Calculus: [B]
Self-Assessing Your Program
Helen Burn • Highline College

This presentation focuses on a model and self-assessment tool that will enable participants to begin to self-assess how their program supports the transition of diverse learners to calculus. The tools were developed as part of the NSF-funded Transitioning Learners to Calculus in Community Colleges (NSF DUE-IUSE #1625918).

Introducing Precalculus Students to STEM Careers   [F1]
Tiffany Ledford & Gabrielle McIntosh
Edmonds Community College

In an effort to attract a more diverse group of students to STEM fields, we embedded short career-focus videos into our precalculus classes and followed each with a related problem that connected the career to the topic being covered in class. We will share what we did and what we are learning from this project.   **2:35–3:00**

This is the first half of a split session featuring two 25-minute presentations; the abstract for the companion talk follows.

Educational Data Mining: A Study of Usage Patterns in a Quantitative Tutoring Center F2
Robin Angotti, Tyler Shea & Abram Girgis
University of Washington Bothell

Using the emerging field of Educational Data Mining (EDM), analysts can leverage large amounts of student data to discover meaningful information about learners or the structures of the educational system. UW Bothell faculty and undergraduate research (UGR) students extracted institutional data on student demographics and use statistics from a quantitative tutoring center. Using Exploratory Data Analysis and dynamic visualization software, the team studied differences in usage by gender and ethnicity, as well as the correlation of use and student grade. The team will discuss the process of mining data, data cleaning, joining multiyear data sets from two sources, and externalizing student data in graphical form for end users to explore, along with preliminary study results and the challenges and opportunities of involving UGR students in EDM. **3:00–3:25**

Undergraduate Research Projects Woven Into Remedial Math Curriculum G
Michal Ramos • Yakima Valley College

Opportunities for undergraduate research (UGR) predominantly arise for students with college-level standing in mathematics and science. Yet meaningful UGR projects can be facilitated within a remedial math course to expose students to the rewarding and motivating experiences of collecting data, designing experiments, interpreting outcomes, and presenting findings to a diverse audience. These projects can address issues directly related to the campus to generate more buy-in from student participants. Standard math concepts and skills taught in remedial courses are directly applied to such projects. This talk will discuss a case study involving two cohorts of students: one in accelerated Pre-Algebra/Beginning Algebra and another in accelerated Beginning/Intermediate Algebra.

Play More Games! H
Mike Kenyon • Green River College

We live in a "golden age" of games, especially board games and card games. Some of these are appropriate to the mathematics classroom and can enhance student engagement as well as understanding, both at the conceptual level and with specific content. We will explore a few. Come ready to play!

Everyone is invited to play some board and card games in Ballroom H following the conclusion of this talk.

WAMATYC Annual Membership Meeting
Friday 3:30–4:30 p.m. G

All current and prospective members of WAMATYC, the Washington state affiliate of the American Mathematical Association of Two-Year Colleges, are welcome to attend.

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Keynote Address
Friday 7:15–8:15 p.m.

Exploding Dots: The Mathematical Phenomenon That Is Sweeping the Globe D
James Tanton • Mathematical Association of America

What are those strange dots-and-boxes diagrams scattered throughout the conference program? What has 4.6 million teachers and students all across the globe abuzz with excitement? What piece of genuine mathematics can be so exciting and so engaging so as to cause adults and kids alike to leap out of their seats and yell out "KAPOW"? Why it is Exploding Dots, of course! Experience the joy and awe that comes from pushing a simple mathematical idea to the max. See the math you know like you've never seen it before, and see math you've likely never seen. Warning: It is best to come to this experience with an extra pair of socks — your first pair will be knocked right off!

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INVITED SPEAKERS

Dr. James Tanton is an ambassador for the Mathematical Association of America currently serving as their mathematician-at-large. He has taught mathematics at both university and high-school institutions, works with students of all ages and backgrounds to experience the wonder of mathematics, has authored many books about math puzzles and problem-solving, and co-founded the Global Mathematics Project, which in its first year helped more than 1,000,000 students from over 100 countries explore Tanton's world-famous "Exploding Dots" during Global Math Week 2017.

Dr. Luke Rawlings was born and raised in Memphis, where he earned a B.S. in Mathematics at Christian Brothers University. After years of training as a competitive gymnast, he moved to New York City to become a performer on Broadway. Following a successful theater career, Luke earned a masters in pure mathematics at the City College of New York and then an Ed.D. in Mathematics Education at Teachers College, Columbia University. Throughout all of these experiences, he has designed tessellations inspired by the art of M.C. Escher. Luke has taught at Bellevue College since 2016.

Olga Shatunova, a lecturer in the School of Interdisciplinary Arts & Sciences at the University of Washington Tacoma, has focused her studies on discrete mathematics with an emphasis on diagram completeness of deterministic finite automata. In her teaching, she incorporates her own diverse cultural background and life experience. Born and educated in Russia, she has taught mathematics in Moscow at the University for Engineers of Metallurgy and Aviation Institute and in Washington at several community colleges. She has worked, taught and developed curriculum in Russia, France, Germany and the United States.

Session VI — Saturday 9:30–10:20 a.m.

Math Pathways: What's Working, What's Not [A]
Bill Moore • SBCTC | Helen Burn • Highline College
Barbara Alvin • Eastern Washington University

An update on the current "state of the art" regarding math pathways as the formal Washington Math Pathways to Completion initiative wraps up. Topics will include: what colleges are doing with respect to pre-college pathways in math; how math pathways are being integrated with "guided pathways"; and what a study of math course-taking tells us about how well existing math pathways are working for transfer students.

Calculus Fun Facts [B]
Jeff Eldridge • Edmonds Community College

When defining a Riemann sum, does it suffice to consider only regular partitions? If so, is there any reason to use non-regular partitions? Is there a way to develop MacLaurin polynomials (with error bounds!) without knowing anything about infinite or alternating series? Why do we use the ∂ symbol to denote the boundary of a region as well as a partial derivative? And more!

Artistic Math Using 3D Printing [F]
Lee Singleton • Whatcom Community College

Learn about Math 175, "Grasp the Math: Intro to 3D Printing," a class for students to explore 3D design work with an emphasis on using mathematics in the design process. Students learn how to design objects for 3D printing using OpenSCAD (and a few other free programs), starting with basic shapes but learning to incorporate space curves and parametric surfaces by the end of the course. See samples designed by students, assigned projects, class resources, and the artistry that only math can provide.

Card Flipping: A Mathematical Solitaire Game [G]
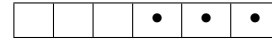Matthew Meerdink • Highline College

We will learn to play a game of mathematical solitaire and solve it. Then we will try to find new, similar games to solve.

Integrating Pre-college Math With Science [H]
Rheannin Becke • Clark College

This session will provide a glimpse at how Clark College Transitional Studies has integrated math and science into a beginning algebra class. You will get to try some activities where students practice math in the context of science.

Session VII — Saturday 10:40–11:30 a.m.

More Exploding Dots: Weird and Wild Fun [A]
James Tanton • Mathematical Association of America

You might be sockless, but come anyway! In this session let's really get wild and crazy. Let's play with fractional bases, negative bases, irrational bases, decimals and -adics — and whatever weird and marvelous concoctions we can devise. Let's even try to solve an open problem or two or three!

Getting Started With Desmos and Blender [B]
Salah Abed • Big Bend Community College

Do you spend a lot of time graphing in class? Do you spend minutes at a time hand-waving explanations for what solids of revolution and two-sheet hyperboloids look like in $\mathbb{R}^3$? Do you try to animate graphs and realize you have nothing but a marker and a stationary whiteboard? At this talk, I'll get you up and running in Blender and Desmos, and we'll share tips and tricks that we've discovered along the way. Bring your own examples to share with the group, or bring yourself and come to learn!

Co-requisites: A Roundtable Discussion [F]
Facilitator: David Lippman • Pierce College Ft. Steilacoom

Is your college considering a co-requisite model where students who place into developmental math are allowed to take a college-level course with co-requisite support? Come discuss your ideas, plans and research with others.

Gray Codes: An Unusual Application to Trigonometry [G]
Richard Plagge • Highline (emeritus) & Pierce Colleges
Olga Shatunova • University of Washington Tacoma

Gray codes (named after Frank Gray, who invented them in 1940s at AT&T Bell Laboratories to minimize the effect of errors in transmitting digital signals) are widely used to facilitate error correction in digital communications such as digital television and some cable TV systems. We will discuss the history and practical applications of Gray codes and introduce an unusual application to trigonometry.

Idea Café: Course Redesign [H]
Facilitator: Luke Rawlings • Bellevue College

An active-participation collaborative session providing an opportunity for faculty to redesign a course by weaving together a story to appeal to current students and incorporate modern approaches.

SPECIAL THANKS

ATTENDEES

Bates Technical College
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Jacob Anderson
Lorna Larsen
Tom Pugh

exhibitors
Cengage
John Wiley & Sons
Knewton Inc.
Pearson
WAMAP/OpenTextBookStore
XYZ Textbooks

denotes presenter

Challenge Problem Solutions

1. Using integration by parts with $u = x$ and $dv = x^{49}\left(1 - x^{50}\right)^{100} dx$: $A = \int_0^1 \left(1 - x^{50}\right)^{101} dx = \int_0^1 \left(1 - x^{50}\right)^{100} dx -$

$$\int_0^1 x \cdot x^{49}\left(1 - x^{50}\right)^{100} dx = W - \left[\frac{-1}{5050}\int_0^1 x\left(1 - x^{50}\right)^{101} dx + \frac{1}{5050}\int_0^1 \left(1 - x^{50}\right)^{101} dx\right] = W - \frac{1}{5050}A \implies \frac{W}{A} = \frac{5051}{5050}.$$

2. $\displaystyle\prod_{k=1}^{2018} \cos\left(\frac{k\pi}{1009}\right) = -\prod_{k=1}^{1008} \cos^2\left(\frac{k\pi}{1009}\right) = -\prod_{k=1}^{504} \cos^4\left(\frac{k\pi}{1009}\right) = -C^4$ where $C = \displaystyle\prod_{k=1}^{504} \cos\left(\frac{k\pi}{1009}\right)$ so if $S = \displaystyle\prod_{k=1}^{504} \sin\left(\frac{k\pi}{1009}\right)$:

$$SC = \prod_{k=1}^{504} \sin\left(\frac{k\pi}{1009}\right)\cos\left(\frac{k\pi}{1009}\right) = \frac{1}{2^{504}}\prod_{k=1}^{504} \sin\left(\frac{2k\pi}{1009}\right) = \frac{1}{2^{504}}\prod_{j=1}^{504} \sin\left(\frac{j\pi}{1009}\right) = \frac{S}{2^{504}} \implies C = 2^{-504}$$

using the identities $2\sin(\varphi)\cos(\varphi) = \sin(2\varphi)$ and $\sin(\psi) = \sin(\pi - \psi)$, hence $-C^4 = -2^{-2016}$.

3. If the rightmost intersection point of the line and the curve is (b, c), then $\displaystyle\int_0^b \left[2018x - 50x^3 - c\right] dx = 0$ so:

$$1009b^2 - 12.5b^4 - bc \implies c = 1009b - 12.5b^3 = 2018b - 50b^3 \implies b = \sqrt{\frac{2018}{75}} \implies c = \frac{2018\sqrt{2018}}{15\sqrt{3}}$$

4. Let X be the number of distinct badges she selects, and for $1 \le k \le 50$ let $X_k = 1$ if badge k is among those selected and 0 otherwise. Hence $E\left(X_k\right) = 1 - \left(\frac{49}{50}\right)^{18}$ so $E(X) = \displaystyle\sum_{k=1}^{50} E\left(X_k\right) = 50\left(1 - \left(\frac{49}{50}\right)^{18}\right) \approx 15.24$.

5. $\dbinom{18 + 4 - 1}{4 - 1} - \left[\dbinom{21 - 7}{3} + \dbinom{21 - 5}{3} - \dbinom{21 - 12}{3}\right] - 1 = 1330 - [364 + 560 - 84] - 1 = 489$

6. If b_k is the amount in B after k iterations then $b_{k+1} = \frac{1}{2}\left(50 - b_k\right) + \frac{5}{8}b_k = 25 + \frac{1}{8}b_k$. Because $\{b_k\}$ is bounded $(0 \le b_k \le 50)$ and monotonic (by induction, considering the cases where b_0 is greater than, less than, or equal to $\frac{200}{7}$ liters), $\beta = \displaystyle\lim_{k\to\infty} b_k$ exists, so $\beta = 25 - \frac{1}{8}\beta \implies \beta = \frac{200}{7}$ liters (regardless of the original amounts in A and B).

7. $I = \displaystyle\sum_{k=0}^{49} \int_0^\pi e^{t+k\pi}\left[\cos^{2018}(t + k\pi) + \sin^{2018}(t + k\pi)\right] dt = \sum_{k=0}^{49} e^{k\pi} \cdot J \implies \frac{I}{J} = \frac{e^{50\pi} - 1}{e^\pi - 1}$.

8. $P\left(\alpha < \beta < \gamma < \delta < \epsilon\right) = \frac{910252}{12000000} = \frac{227563}{3000000} \approx 0.07585433333$; see `http://goo.gl/UgBmNX` for details.

9. When the hour hand moves through an angle θ, the minute hand moves 12θ and the second hand 720θ. The minute hand is opposite the hour hand when $\theta + \pi = 12\theta \implies \theta = \frac{\pi}{11}$, and at 12:50 a.m. $\theta = \frac{5\pi}{36}$. The second hand is *not* on the same side of a diameter of the clock as the hour and minute hands for $\frac{(2k+1)\pi}{719} < \theta < \frac{(2k+1)\pi}{708}$ when $\theta < \frac{\pi}{11}$ and for $\frac{(2k+1)\pi}{708} < \theta < \frac{(2k+3)\pi}{719}$ when $\theta > \frac{\pi}{11}$, hence the total time when all three hands are *not* on the same side of a diameter is:

$$50 \cdot \frac{36}{5\pi} \cdot \pi\left(\left[\frac{1}{708} - \frac{1}{719}\right]\sum_{k=0}^{31}(2k+1) + \left[\frac{1}{11} - \frac{65}{719}\right] + \frac{2 \cdot 17}{719} + \left[\frac{1}{719} - \frac{1}{708}\right]\sum_{k=32}^{48}(2k+1) + \left[\frac{5}{36} - \frac{99}{708}\right]\right)$$

and the total time when the hands *are* on the same side of a diameter simplifies to 35 minutes and $52 + \frac{354088}{466631}$ seconds.

10. For constants A, B and C, and some polynomial $P(x)$ with degree $d - 3 \le 2015$, $\frac{\pi(x)}{x^3 - x} = P(x) + \frac{A}{x} + \frac{B}{x - 1} + \frac{C}{x + 1}$ so write $\frac{d^{2018}}{dx^{2018}}\left[P(x) + \frac{A}{x} + \frac{B}{x - 1} + \frac{C}{x + 1}\right]$ as:

$$0 + \frac{A \cdot 2018!}{x^{2019}} + \frac{B \cdot 2018!}{(x - 1)^{2019}} + \frac{C \cdot 2018!}{(x + 1)^{2019}} = 2018! \cdot \frac{A\left(x^2 - 1\right)^{2019} + Bx^{2019}(x + 1)^{2019} + Cx^{2019}(x - 1)^{2019}}{(x^3 - x)^{2019}}$$

hence $\varphi(x)$ is a (polynomial) multiple of the numerator. Choosing that multiple to be 1 and noting that $ABC \ne 0$:

$$\varphi(x) = (A + B + C)x^{4038} + 2019(B - C)x^{4037} + 2019(-A + 1099B - 1009C)x^{4036} + \mathcal{O}\left(x^{4035}\right)$$

If $B = C$ and $A = -2B$ the x^{4038} and x^{4037} coefficients are 0 while that of x^{4036} is $-A \ne 0$. The minimal degree is 4036.

Challenge Problem Sources

1. Problem #45 on page 101 of *How to Integrate It* by Seán M. Stewart.

2. `http://sigmaa.maa.org/mcst/documents/WRANGLEJMM2018.pdf`

3. Adapted from Problem A1 on the 1993 Putnam Exam.

4. Adapted from: `https://goo.gl/9AoK4v`

5. Variation of classic "stars and bars" problem.

6. Variation of: `https://twitter.com/jamestanton/status/980072187091550209`

7. Variation of #21 on page 50 of *How to Integrate It*.

8. `https://twitter.com/jamestanton/status/963763305000005632`

9. `https://twitter.com/jamestanton/status/896724811287715840`

10. Adapted from Problem B4 on the 1992 Putnam Exam.

7:30–9:00 p.m.   Opening Session featuring Luke Rawlings

FRIDAY

7:00–8:30 a.m.   **Breakfast**

	A	B	F	G	H
I 8:50–9:40 a.m.	Pre-college Math Reform Update Mitchell	Accessibility in WAMAP Lippman	Flippin' Statistics Wallace	Mathematical Notation and Symbols Lal	Game On! Using Play to Engage Glen
II 9:55–10:45 a.m.	Continuity and Context in Statistics Mauney	Math in Motion: Physics and Calculus Ursin & Mallare-Dani	High School Math Assessment Wallace	Musical Tuning and Temperament Mack	Liven Up Your Class With Kahoot! Lippert & Li
III 11:00–11:50 a.m.	The Algebra of Technology Shatunova	Implementing Math Pathways Hugo & Story	Vorticity in Basic Multivariable Calculus Nievergelt	Get Your Students Involved Marx	Dollar Street: A New Kind of Data Mudzimiri & Angotti

12:00–1:15 p.m.   Lunch

	A	B	F	G	H
IV 1:30–2:20 p.m.	Graphing Without a Calculator Webber	Transfer Experience Tou, Skipper, Heaven & Rajopadhye	Outcomes From Redesigning Basic Math Orr & Luttrell	Accelerated Math Pathway via I-BEST Cary	Puzzle Morsels Krishna
V 2:35–3:00 p.m.	Virtual Manipulatives for Mathematics Marfai & Meacham	Transitioning Learners to Calculus Burn	Introducing Precalculus Students to STEM Careers Ledford & McIntosh	UGR Projects in Remedial Math Ramos	Play More Games! Kenyon
3:00–3:25 p.m.	↓	↓	Educational Data Mining Angotti, Shea & Girgis	↓	↓

6:15–8:15 p.m.   Dinner and Keynote Address featuring James Tanton

SATURDAY

7:30–9:00 a.m.   **Breakfast**

	A	B	F	G	H
VI 9:30–10:20 a.m.	Math Pathways: What's Working, What's Not Moore, Burn & Alvin	Calculus Fun Facts Eldridge	Artistic Math Using 3D Printing Singleton	Card Flipping: A Solitaire Game Meerdink	Integrating Pre-college Math With Science Becke
VII 10:40–11:30 a.m.	More Exploding Dots: Weird and Wild Fun Tanton	Getting Started With Desmos and Blender Abed	Co-requisites Roundtable Lippman	Gray Codes: An Application to Trig Plagge & Shatunova	Idea Café: Course Redesign Rawlings