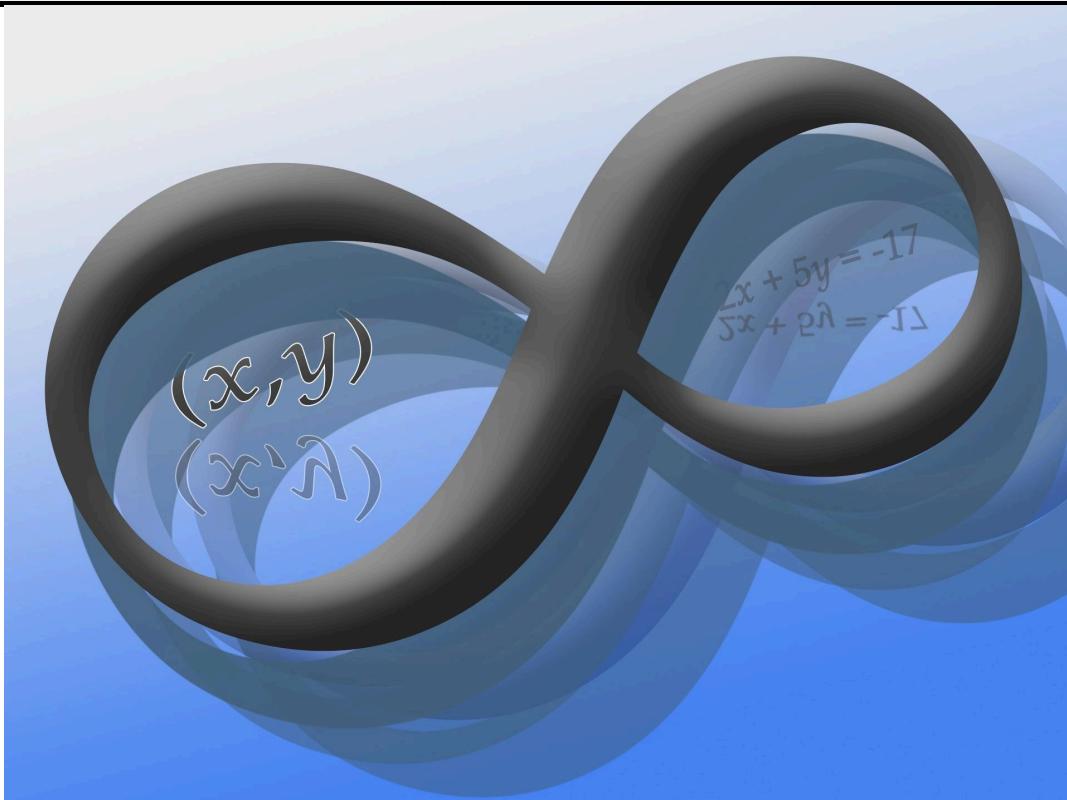




An Official Publication of the  
Pennsylvania Council of  
Teachers of Mathematics





## The Pennsylvania Council of Teachers of Mathematics

Cover Credit:  
Google Images  
Photos: Thankful Math

Volume LXIV  
Number 2  
Fall 2024

### Table of Contents

3. PCTM Editor's Message
4. President's Message
6. PCTM Happenings
9. From the Classroom
20. Article: "Instant Answers": Exploring Artificial Intelligence Tools Accomplishing Mathematics Responses
29. Article Call

PCTM Magazine is published twice each year by the Pennsylvania Council of Teachers of Mathematics, an affiliate of the National Council of Teachers of Mathematics.

Articles and announcements for **PCTM Magazine**, an editor-reviewed publication, should be submitted electronically to the editors via [pctm.editor@gmail.com](mailto:pctm.editor@gmail.com)

The PCTM Magazine co - editors are:

Daniel R. Ilaria West Chester University	Xiangquan (James) Yao Penn State University	Karise Mace Kutztown School District
---------------------------------------------	------------------------------------------------	-----------------------------------------

## Hello from the Editors

Daniel R. Ilaria, Karise Mace & Xiangquan (James) Yao

Dear Readers:

Welcome to Fall! The Fall 2024 issue of the PCTM Magazine shares information gathered from around the state about mathematics education. This issue features summaries of the PCTM annual conference, award winners and election information. This magazine relies on the professionals this magazine serves to share what you are doing in the profession, how you are growing in your practice, and communicating about great experiences around the state. Please share what you are doing by checking out the call for manuscripts or sending an email to contribute to other sections of the magazine.

**PCTM's Annual Conference was held in July 2024.** Check out the Happenings section to read about the event and see the PCTM award winners recognized at the conference.

Keep checking pctm.org for more information about 2025 events, including the annual conference on July 23 - 25, 2025 at the Best Western Premier Hotel and Conference Center in Harrisburg, Pa. Speaker proposals are open from October 15th through December 15th.

Contribute to the “From the Classroom” section of the magazine. Please send images of your mathematicians at work or engaging in your own professional learning! Send images with caption information to [pctm.editor@gmail.com](mailto:pctm.editor@gmail.com).

*Welcome to PCTM Magazine co-editors:* Karise Mace & James Yao

Enjoy,

Dan, Karise, & James



Please email your comments, suggestions, articles, etc. to [pctm.editor@gmail.com](mailto:pctm.editor@gmail.com). More information on submission guidelines may be found on the last page of this issue.

## President's Welcome Letter Message

Fall 2024

With Fall comes a flurry of activity. The color changes of the tree leaves across Pennsylvania make a beautifully arrayed color pallet. Leaves fall and they crunch under our feet making a crisp sound that brings with it the thought of the winter rest followed by the new birth of spring. Fall is my favorite season of the year. I love the crispness of the cooling air and the invigoration of being outside doing yard work or sitting near a small bonfire or firepit toasting marshmallows and taking long walks in the park. Along with this ecological scene comes the start of a new school year and the whirlwind of activity it brings to educators and families alike. The excitement of opening your classroom, which I always started on August 1<sup>st</sup> or whatever weekday was closest to it like many of you who I know do the same thing now, putting up posters and signs and displays, preparing for that first day of school with the anticipation of meeting your students and instilling within them the joy of mathematics and learning to learn through the discipline of mathematics.

Just a few weeks ago the special issue of the NCTM *Mathematics Teacher PK-12; Learning Teaching: Gaining Traction w/Actions 10 years* arrived in my mailbox. I remember when the NCTM publication *Principles to Actions: Ensuring Mathematical Success for All* made its debut. Do you remember where you were when the *Principles to Actions* came out? I was in my 40<sup>th</sup> year of teaching and preparing to retire at the end of June 2014, or was I already retired? Ten years is a long time! However, I remember reading through it and thinking it would have been amazing to have this resource in my early years of teaching. Perhaps then I would not have had the great struggle to figure things out for myself in those early years when research on education and teaching practices was limited and trial and error made for learning what worked with success and what did not. In 2000 NCTM introduced its newest book, *Principles and Standards for School Mathematics*. This was an amazing resource and I still have my copy which I used frequently in my teaching practice. Today there is so much at your fingertips and Google search makes it so easy. Google Docs was just starting to be used in my school the year after I retired and has now become one of the leading ways to communicate with colleagues and share information. Now I rely on my younger colleagues to help me learn how to navigate in Google Docs, and boy have they been amazing and kind in this journey for me. Reach out to others for help in learning the craft of teaching, whether the mentors be older or younger than you, as they are a very valuable resource for you. Share what you have with others and ask others for their opinion and help in your teaching journey. Keep in mind that you are never too old to learn either. One of my young colleagues has taught me how to set up and run a Google Meet for a group of educators and I am very thankful.

I miss those days teaching in the classroom and hearing the AHA moments of learning and understanding. This past calendar year I have had the privilege to substitute at a small Academy near my home where I have greatly enjoyed my time spent learning with children. It is a great joy and pleasure to be able to be of help to the younger generation of teachers. That story will keep for another time, but it reminds me greatly of what I have learned about teaching and still have in my memory banks to share with others. My passion for teaching has never been stronger, it never retired along with my 40 years in Public Education, rather it continues to grow as I remain active in professional mathematics organizations, attend conferences, present workshops for teachers, network with teachers, and read up on some new insight in education. There is great worth in attending conferences that are local and I encourage you to make time to attend the 2025 PCTM Annual Conference that will be held in Harrisburg next July 2025. We

travel to Pittsburgh for the 2026 PCTM Annual Conference and will celebrate PCTM's 75<sup>th</sup> Anniversary there with some exciting, fun and interesting events. The Program Chairs are currently accepting proposals for the 2025 Conference. PCTM and PAMTE will partner in presenting a Fall Professional Development Day for both Pre-Service Teachers and In-Service Teachers in the fall each year. This event will be held in the southeastern region of Pennsylvania for the fall of 2025. Information regarding any PCTM events as well as affiliate events and other local mathematics opportunities can be found on the PCTM website at [www.pctm.org](http://www.pctm.org).

My best to all of you as you make this journey in teaching! Feel free to reach out to me anytime at [marian@pctm.org](mailto:marian@pctm.org) . Have a wonderfully blessed year filled with good health and lots of joy!

Marian Avery, PCTM President





# Happenings

## 2024 PCTM Conference

### 2024 PCTM Annual Conference Energizes Educators

The 2024 PCTM annual conference, Math Matters:Empowering Teachers to Transform Learning, was held in Malvern from July 24 to July 26. The conference was attended by over 125 educators and supported by 14 vendors. Over 40 hour-long breakout sessions were held on a variety of topics spanning grades K-12. The PCTM annual awards and the general membership meeting for PCTM was also held.



Pre-conference speaker Leo Valencia gave a talk entitled “Facilitating MathPlay while Building Community and Increasing Student Engagement”. Libo described how math play can make a more enjoyable mathematics experience for all students, lead to deeper mathematical understanding and build a collaborative community. Attendees saw practical examples of how they could incorporate math play with students in their classrooms, including using Lego figures and pattern blocks to the creation of an ellipse with Pringles potato chips.



The conference began on Thursday morning with IGNITE talks from math educators Monique Dirks, Leigh Nataro, Valerie Long and Joelle Cooper. The keynote speaker on Thursday was Dr. Amanda Jansen from the University of Delaware. Dr. Jansen's address "Revising in Mathematics Classes" was very interactive, eliciting feedback and questions from the audience in multiple ways. She reminded teachers that revising likely happens in a variety of ways in their classrooms from how instructional routines are used to various assessments. Revising in mathematics helps students see that revising is an integral part of learning mathematics and leads to more perseverance with more challenging math concepts. The keynote speaker on Friday was NCTM president Kevin Dykema. Kevin spoke about "Increasing Opportunities for Students in Mathematics" and described how NCTM and other state education agencies are making changes to policies to address equity with the teaching and learning of mathematics.



The 2025 conference will be held at the Best Western Conference Center in Harrisburg from July 25-27. The pre-conference speaker will be Dan Kauffman and keynote speakers include Deborah Peart, founder of My Mathematical Mind and the founder of Desmos, Eli Luberoff. If you have a great idea to share for a one-hour breakout session, a link to submit your proposal will be posted on the PCTM website at [pctm.org](http://pctm.org) during the month of October. The submission window is October 15th through December 15th.

## 2024 PCTM Award Winners

The 2024 PCTM Awards were announced at the Pennsylvania Council of Teachers of Mathematics annual conference that was held in Malvern on July 25, 2024.



From Left to Right:

The Outstanding Contribution to Mathematics Education Award: Robert Sun, Inventor of the 24® Game

The Mathematics Hall of Fame Award: Heather Reo, Saltsburg Elementary School

PCTM New Teacher Award: Michael Anzaldo, The Montgomery School

The Master of Mathematics Award (Middle School): Brittany Capparell, Heights-Terrace Middle School

The Master of Mathematics Award (High School): Stephanie Hickman, Upper Darby School District

Not Pictured: The Annalee Henderson Outstanding Student Achievement Award,  
Jace Parks, West Shamokin High School

## Nominations for the PCTM Awards Open November 1

Do you know an outstanding math educator or math education supporter? Do you know an excellent high school senior who plans to go into a math-related field? Nominate them for the annual PCTM awards. Nominations for all awards will open on November 1st and close on March 30th the following year. Nominations will be submitted via a google form found at [pctm.org/awards](http://pctm.org/awards). Nominations will require a link (or upload) of a letter of recommendation describing the candidate's qualifications for the award. All nominators will be contacted about the status of the award on or around April 30th. Educator awards will be presented at the PCTM Annual conference and educator award winners receive a free conference registration.

**The Outstanding Contribution to PCTM Award:** This award will be presented to a member of PCTM who has demonstrated outstanding service and leadership to the organization over many years. The individual could have served in a variety of capacities or may have served in a single leadership role for many years.

**The Outstanding Contribution to Mathematics Education Award:** This award will be presented to a mathematician, or a mathematics educator from a public or private school, college or university, or industry, who has made an outstanding contribution to mathematics education in Pennsylvania. The person being nominated for the award must teach or work in Pennsylvania.

**The Mathematics Hall of Fame Award:** This award will be presented to the mathematics educator in Pennsylvania who is regarded by his/her peers as making the greatest impact on mathematics students and has continually exemplified excellence as a mathematics educator.

**The Master of Mathematics Award:** This award will recognize math educators at four different levels of education: Primary Master of Mathematics: Grades K-2, Intermediate Master of Mathematics: Grades 3-5, Middle School/Junior High School Master of Mathematics and High School Master of Mathematics. The new teacher must be nominated by a supervisor, an administrator or a colleague. To be nominated for this award a candidate must:

1. Be a teacher in a public/private school (at any level, K-12) who teaches mathematics in the state of Pennsylvania.
2. Have completed at *least* seven years of full-time teaching.
3. Exhibit contagious enthusiasm for students' learning of mathematics.
4. Demonstrate initiatives in developing innovative strategies in his/her teaching.

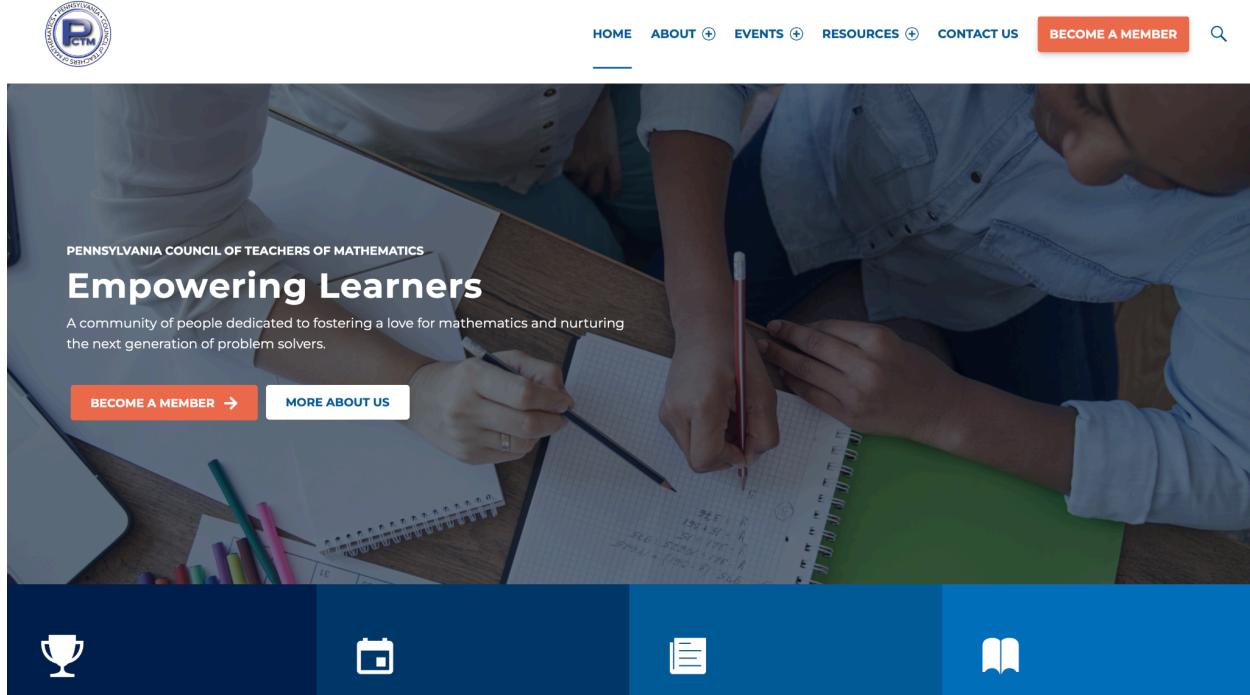
**The PCTM New Teacher Award:** The purpose of the award is to recognize promising, beginning teachers of mathematics so that they will be encouraged to remain in the profession. This award includes three years of free membership to PCTM. The new teacher must be nominated by a supervisor, an administrator or a colleague. To be eligible for this award the candidate must:

1. Be a teacher in a public or private school (at any level, K-12) who teaches mathematics in the state of Pennsylvania.
2. Have completed the first, second, or third year of his/her first full-time teaching experience.
3. Exhibit contagious enthusiasm for students' learning of mathematics.
4. Demonstrate initiatives in developing innovative strategies in his/her teaching.

**The Distinguished Service Award:** Upon the completion of the Annual conference, nominations will be accepted for the Distinguished Service award. The award may go to the General Chairperson of that Annual Conference, the Program Chairs of that Annual Conference or any PCTM Conference Committee Chairperson who has done an outstanding job in carrying out the function of his or her committee. The nominator must submit in writing to the Awards Committee, the person's name, the committee chaired and reasons the person is deserving of the award.

**Annalee Henderson Award:** The Annalee Henderson Outstanding Student Achievement Award is presented annually to a high school senior who has demonstrated excellence in mathematics and whose future plans include mathematics or a mathematics-related field. The student must have completed a variety of high level mathematics courses which reflect a genuine interest in, and talent for, mathematics. High SAT scores and the participation in mathematics contests and original work or research in mathematics presented for math and science fairs and clubs is required. The student must have a good overall academic record and be involved in other activities (inside or outside of school). This award includes a monetary amount of \$1000.

# NEW PCTM WEBSITE!!!



The PCTM website recently got an upgrade to improve functionality and the user experience. Displaying a new color scheme and layout, the new PCTM website is a one-stop-shop for all information about PCTM. Are you looking to get involved with PCTM? The updated website has a section with the various ways in which you can become a more active member of PCTM. The updated site will continue to have information about upcoming PCTM events, PCTM award nominations, and other general pieces of information about PCTM. Stay tuned for an updated Resources section coming soon that will include classroom resources for all levels. These resources offer ways to engage and inspire learning and create a positive classroom environment!

PCTM also has a new Facebook page! Make sure to like and follow the PCTM.org Facebook page by either searching for PCTM.org in the Facebook app or clicking on the Facebook logo in the footer on the PCTM webpage. Following our new Facebook page is a great way to join the PCTM community and receive important updates and announcements!

## PCTM Professional Development Day

### September 21, 2024

On September 21<sup>st</sup>, educators participated in PCTM Professional Development Day held at Carlisle High School. Participants were able to engage in a variety of hands-on sessions that focused on innovative strategies and tools to enrich classroom learning. Educators also had time to collaborate with teachers from various districts, providing an opportunity for conversations and the sharing of best practices among peers. Overall, PCTM Professional Development Day was a success, reinforcing the vital role of ongoing professional development in shaping the future of education.



## PCTM Spring 2025 Board Nominations and Elections

**Dear PCTM Members,**

Please consider nominating yourself or a colleague for the Delegate at Large or for one of the PCTM Regional Representatives for the PCTM Spring 2025 Elections.

A nominee for the **Delegate at Large** position must be a mathematics-based educator employed in the state of Pennsylvania, including the classroom at any level, Math Coaches/Supervisors, or Intermediate Unit. The Delegate at Large represents areas anywhere throughout the state.

A nominee for a **Regional Representative** position must be a full-time PreK-12 classroom teacher, employed in the state of Pennsylvania by a school, having students in their classroom all day, and with a day-to-day interaction with students.

There are three positions open on the Board, one for each of the Regional Areas of Pennsylvania:

**Eastern Regional Representative** (IU's 13, 14, 18, 19-26 & 29)

**Central Regional Representative** (IU's 08-12, 15, 16 & 17)

**Western Regional Representative** (IU's 01-07, 27 & 28)

Responsibilities of these positions:

1. Attend the Board meetings as listed.
  - July 23, 2025 – 2:00-3:30 PM – Best Western Premier the Central Hotel & Conference Center, 800 East Park Drive, Harrisburg, PA 17111 - during the Annual Conference. This is the only face-to-face Board meeting
  - November 6, 2025 – 6:30-8:30 PM – Via ZOOM (note: this is a Thursday evening)
  - February 5, 2026 – 6:30-8:30 PM – Via ZOOM (note: this is a Thursday evening)
  - April 23, 2026 – 6:30-8:30 PM - Via ZOOM (note: this is a Thursday evening)
2. Utilize your voice and vote on all Board decisions and motions.
3. Provide input at the Board meetings concerning agenda items.
4. Bring forth new ideas and suggestions that PCTM might be able to facilitate to benefit the teachers of Pennsylvania.

If interested, please send the following information to Dave Kennedy at [DIKenn@ship.edu](mailto:DIKenn@ship.edu) by 11:00 PM on Friday, January 17, 2025. In the subject line type: PCTM Nominations 2025

- Headshot photo of yourself that can be posted online for the elections in early March
- One-paragraph bio that can be posted online for the elections in early March
- School District & School Building Name/Charter/Academy/Private School
- Grade level you teach (Elementary, Middle School, High School)
- IU number

Thank you,  
Dave Kennedy  
PCTM 2025 Nominations and Elections Chair

## 2024 Pennsylvania Statistical Poster Competition Winners

The Mathematics Department at Saint Francis University is pleased to announce the winners of the 2024 Pennsylvania Statistics Poster Competition. The annual state competition is in its twenty eighth year overall and coordinated for the sixteenth year by Saint Francis University. Cash awards of \$96 for first place, \$72 for second place, \$48 for third place, and \$24 for fourth place in each of four grade levels are awarded to the students who submitted winning posters. External financial support is provided by several regional and state professional organizations, including the Pennsylvania Council of Teachers of Mathematics, Mathematics Council of Western Pennsylvania, Pittsburgh Chapter of the American Statistical Association, Harrisburg Chapter of the American Statistical Association and Philadelphia Chapter of the American Statistical Association. A statistics poster is a display containing two or more related graphics that summarize a set of data, looks at the data from different points of view, and answers specific questions about the data. The 263 posters submitted electronically included 66 in the K-3 grade category, 57 in the 4-6 grade category, 53 in the 7-9 grade category, and 87 in the 10-12 grade category. These 263 posters were submitted from a total of 446 students! Judging for the state competition was held in April 2024. Winning posters were then submitted to the Data Visualization Poster Competition, which is coordinated by the American Statistical Association. Congratulations to all the students who created and submitted the winning and honorable mention posters, and to the teachers, parents and mentors who guided the students.

### Grades K-3 Winning Posters 2024

**First Place:** Angelina Dinh, *Dirty Secrets in my House*, Rydal Elementary School, Teacher: Pamela DaSilva

**Second Place:** Garrison Bogust and Jack Ullmann, *Precipitous Plunge*, Owatin Creek Elementary School, Teacher: Kathy Walker

**Third Place:** Leslie Kuo, *Pizza Hot*, Rydal Elementary School, Teacher: Pamela DaSilva

**Fourth Place:** Dylan Johnston, *How Fast Can I Build Legos?* Rydal Elementary School, Teacher: Pamela DaSilva

**Top Honorable Mention:** Julia Diamond and Juliana Katz, *Bubbling Tastiness*, Jacksonwald Elementary School, Teacher: Kathy Walker

**Honorable Mention:** Veronica McTague, *Here Comes the Granny!* The Baldwin School, Parent: Jaclyn McTague

**Honorable Mention:** Henry Lurwick and Adrian Aziz, *Here Comes the Pop!* Owatin Creek Elementary School, Teacher: Kathy Walker

### Grades 4-6 Winning Posters 2024

**First Place:** Aadit Dutta, *Prediction of Titanic Passenger Survival Using Machine Learning*, Julia Ward Howe Elementary School, Parent: Partha Dutta

**Second Place:** Evelyn Kuo, *Wet Brush, the Best Brush!* Rydal Elementary School, Teacher: Pamela DaSilva

**Third Place:** Etta Permut, *Bullying... Cyber or Physical?* Rydal Elementary School, Teacher: Pamela DaSilva

**Fourth Place:** Mila Wilderman, *Paper Flight!* Rydal Elementary School, Teacher: Pamela DaSilva

**Top Honorable Mention:** Lexi Muskin, *Bypass the Gas*, Rydal Elementary School, Teacher: Pamela DaSilva

**Honorable Mention:** Grace Sullivan, Lucy Kolar and Emily Hubbell, *Chosen Powers*, Highland Elementary School, Teacher: Bonnie Howe

**Honorable Mention:** Alessandra Garibian, *Rhythm Runners*, Rydal Elementary School, Teacher: Pamela DaSilva

### **Grades 7-9 Winning Posters 2024**

**First Place:** Catalina Edu, *Are You Smarter than an AI?* Abington Middle School, Teacher: Pamela DaSilva

**Second Place:** Emily Ditri, *Water Bottles*, Abington Middle School, Teacher: Pamela DaSilva

**Third Place:** Gemma Tait and Aisling Scanlan, *How Long Does It Take for Bread to Mold?* Abington Middle School, Teacher: Pamela DaSilva

**Fourth Place:** Isaac Freeman, *Fully Charged*, Abington Middle School, Teacher: Pamela

**Top Honorable Mention:** Storm Sonntag, *Do Middle Schoolers Prove the Theory of Uncanny Valley?* Abington Middle School, Teacher: Pamela DaSilva

**Honorable Mention:** Swarit Choudhari and Leilah Dinh, *Lights Out! High School vs. Middle School Sleep*, Upper Moreland Middle School, Teacher: Karen Hanssens Wieczorek

### **Grades 10-12 Winning Posters 2024**

**First Place:** Alan Joseph, *Do Therapy Dogs Help Reduce Stress in Students?* Lower Moreland High School, Teacher: Dennis Murphy

**Second Place:** Elliana Koulouris and Joseph Discello, *Don't Stop the Music*, Burrell High School, Teacher: Meaghan Volek

**Third Place:** Ahmed Elmanzalawi, Neal Kochhar and Taiki Murakami, *Facing the Furry Fury with UnBEARable Odds*, State College Area High School, Teacher: Eric Davy

**Fourth Place:** Lila Pileggi, *Can 4-7-8 Breathing Improve Performance on Balance Beam?* Burrell High School, Teacher: Meaghan Volek

**Top Honorable Mention:** Taylor Dentzel and Makenzie Schuller, *Is Senioritis Real?* Burrell High School, Teacher: Meaghan Volek

**Honorable Mention:** Billy Kowalkowski, *Students Opinion on Materialism*, Burrell High School, Teacher: Meaghan Volek

**Honorable Mention:** Amy Liu, Odessa Gregor and Krystal Nguyen, *Beyond the Ballot: Who Represents You?* State College Area High School, Teacher: Jacob Smith

**Honorable Mention:** Alexander Garner, *Does Competitive Marching Band Need a Makeover?* Mifflin County High School, Teacher: Kerry Clancy-Burns

**Honorable Mention:** Ojal Bhattacharai, Nicole Lupo and Eleanor Harper, *Wordle Wizards*, State College Area High School, Teacher: Jacob Smith

**Honorable Mention:** John Cho and Christopher Bahnsen and Caleb Du, *Where do High Schoolers Get Their News From?* State College Area High School, Teacher: Jacob Smith



# SAVE THE DATE

## 2025 PCTM CONFERENCE

BEST WESTERN PREMIER HOTEL  
& CONFERENCE CENTER  
HARRISBURG, PA

**JULY 23-25, 2025**

**2025 CONFERENCE FEATURING**



DAN KAUFMANN  
PRE-CONFERENCE SPEAKER



ELI LUBEROFF  
KEYNOTE SPEAKER



DEBORAH PEART  
KEYNOTE SPEAKER

GO TO [WWW.PCTM.ORG](http://WWW.PCTM.ORG) TO LEARN MORE.

2026 Conference August 5 - 7,  
DoubleTree by Hilton,  
500 Mansfield Avenue,  
Pittsburgh, PA 15205

2027 Conference  
Dates TBD  
Harrisburg, Pa

2025 Conference Speaker Proposals: October 15th - December 15th - See [PCTM.org](http://PCTM.org)

# Become a Peer Tutor and Earn Undergraduate Credits -at No Cost to You!



**Penn GSE**  
GRADUATE SCHOOL OF EDUCATION  
UNIVERSITY of PENNSYLVANIA

**The University of Pennsylvania's Graduate School of Education (Penn GSE) and Thinkist, PBC have partnered to bring Thinkist's math tutoring program to Pennsylvania students!**

*Currently open to all PA students*

The Rural Pathways to Success Federal Grant makes it possible for students to receive a fully funded, accessible, high-quality peer tutoring program.

High school student participants receive both academic and social-emotional training, enhancing their preparedness for postsecondary education and expanding opportunities for future success.

**REGISTER HERE!**



**Penn GSE and Thinkist will provide an evidence-based peer tutoring program that trains high school students in grades 10, 11, and 12 to become peer tutors to students (learners/tutees) in grades 6-12.**



**After successful completion of each tutor training course students earn 4 undergraduate credits. After successful program completion students earn 8 undergraduate credits from the University of Pennsylvania.**



**Spring tutor training courses run from February 10, 2025 to June 1, 2025. Choose the course day and time that works best for your schedule - afternoons, evenings, and weekends are available.**

**NOW ENROLLING Tutors and Tutees for SPRING 2025! Questions? Contact us or visit the FAQ's**

Visit our website for more information: <https://pln.gse.upenn.edu/peer-tutor-training-program>

## FEATURED ARTICLE:

### “Instant Answers”:

#### Exploring Artificial Intelligence Tools Accomplishing Mathematics Responses

Amanda Gantt Sawyer

James Madison University

[sawyerag@jmu.edu](mailto:sawyerag@jmu.edu)

Kaleigh D. Phelps

James Madison University

[phelpskd@dukes.jmu.edu](mailto:phelpskd@dukes.jmu.edu)

Zoe M. McDowell

James Madison University

[mcdowezm@dukes.jmu.edu](mailto:mcdowezm@dukes.jmu.edu)

Courtney M. S. Vreeland

James Madison University

[vreelacm@dukes.jmu.edu](mailto:vreelacm@dukes.jmu.edu)

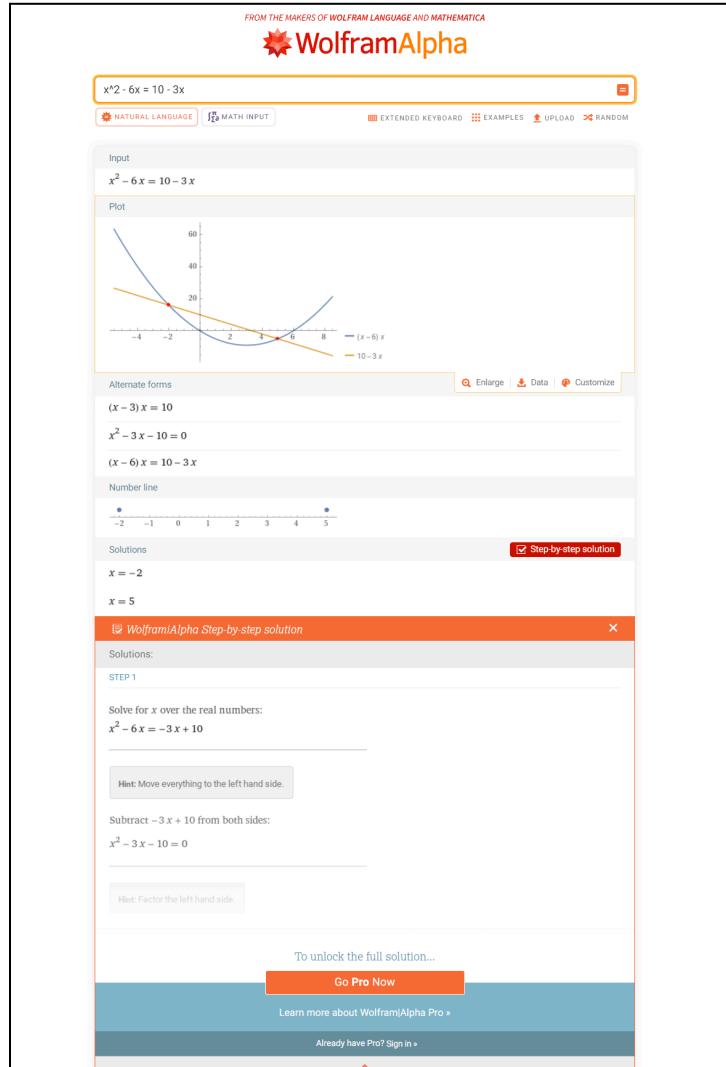
Social media websites bombard students and teachers with advertisements for the newest Artificial Intelligence (AI) tools, which provide you with “Instant Answers, Any Subject” (Smartsolve. 2024). These quick-answering tools could entice many individuals, especially those lacking confidence in their content knowledge. As mathematics teachers, we need to be aware of these technological advancements to support our students' understanding of mathematics meaningfully and curb students' misuse of these AI tools. Researchers identified that AI tools are not consistently mathematically accurate (Sawyer & Aga, 2024), produce biased information (Wu, 2023), and students have difficulty finding AI errors (Sawyer, 2024). Therefore, to keep mathematics teachers informed of the changing landscape, we explore examples of AI tools that can produce mathematical responses. Specifically, we investigated AI platforms that provide solutions from uploaded worksheets, answers to multiple-choice questions, and language

explaining the meaning behind mathematical concepts. Finally, we describe how this could affect teachers' ability to support their students' mathematical development.

### **AI Tools Can Produce Mathematical Responses for Uploaded Problems.**

Given a worksheet, individuals can upload or copy and paste the problem into AI tools like Wolfram Alpha, <https://www.wolframalpha.com/>, or Gauth, <https://www.gauthmath.com/>, and the solution will be given without any cognitive thought. For example, Figure 1 shows an equation typed into Wolfram Alpha that provides a correct graph and solution to the mathematical equation. If a worksheet can be found online, you can easily access the PDF and upload the document, solving the entire worksheet in seconds. Figure 2 shows an online worksheet, found online for free at <https://www.mashupmath.com/>, uploaded to Gauth, which provided correct responses to the questions. This demonstrates that individuals without mathematical knowledge can still create answers to their PDF mathematics worksheets with the help of these AI tools.

However, we must assume that these answers are only sometimes accurate. AI platforms like Gauth can solve the equation and provide step-by-step explanations for how to solve it, as seen in Figure 2. These explanations, while helpful, can lead students astray by solving the problem incorrectly. In Figure 3, Gauth incorrectly solves a similar factoring problem while providing step-by-step explanations for the incorrect solution. In step 3 of the solution, Gauth confidently explains that  $9+4=15$ , a simple addition error that students may overlook if they only focus on copying the steps onto a paper.



**Figure 1:** Example of Typed Equation Solved on Wolfram Alpha (12 September 2024)

The screenshot shows a user interface for Gauthmath.com. On the left, a sidebar lists various tools: Home, Gauth AI, PDF Helper, Writing Helper, Calculator, Resources, and Blog. The main area is titled "Solve Quadratics by Factoring" and contains several math problems. Problem 1:  $p^2 + 10p = 0$ ; Problem 2:  $w^2 + 13w + 3 = 0$ ; Problem 3:  $p^2 - 23p + 132 = 0$ ; Problem 4:  $r^2 + 6r + 54 = 54$ ; Problem 5:  $s^2 + 7s + 6 = -10$ ; Problem 6:  $m^2 - 6m - 55 = 0$ ; Problem 7:  $(2n + 8)(3n + 2) = 0$ ; Problem 8:  $(2n + 8)(3n + 2) = 0$ ; Problem 9:  $z^2 + 4z = 45$ ; Problem 10:  $k^2 - 8k = 0$ . To the right, a "Solve" panel for Problem 4 shows the AI solution:  $r^2 + 6r + 54 = 54$  (rearranged to  $r^2 + 6r = 0$ ), applying the inverse property of addition to get  $r^2 = -6r$ , identifying coefficients  $a = 1, b = 6, c = 0$ , substituting into the quadratic formula  $r = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ , and finding the roots  $r = 0$  or  $r = -6$ . The "Answer" is  $r = 0$  or  $r = -6$ . Below the solve panel, a note from "Math-Aids.Com" says "Alright, let's tackle this equation together!" and provides the equation  $r^2 + 6r + 54 - 54 = 54 - 54$ .

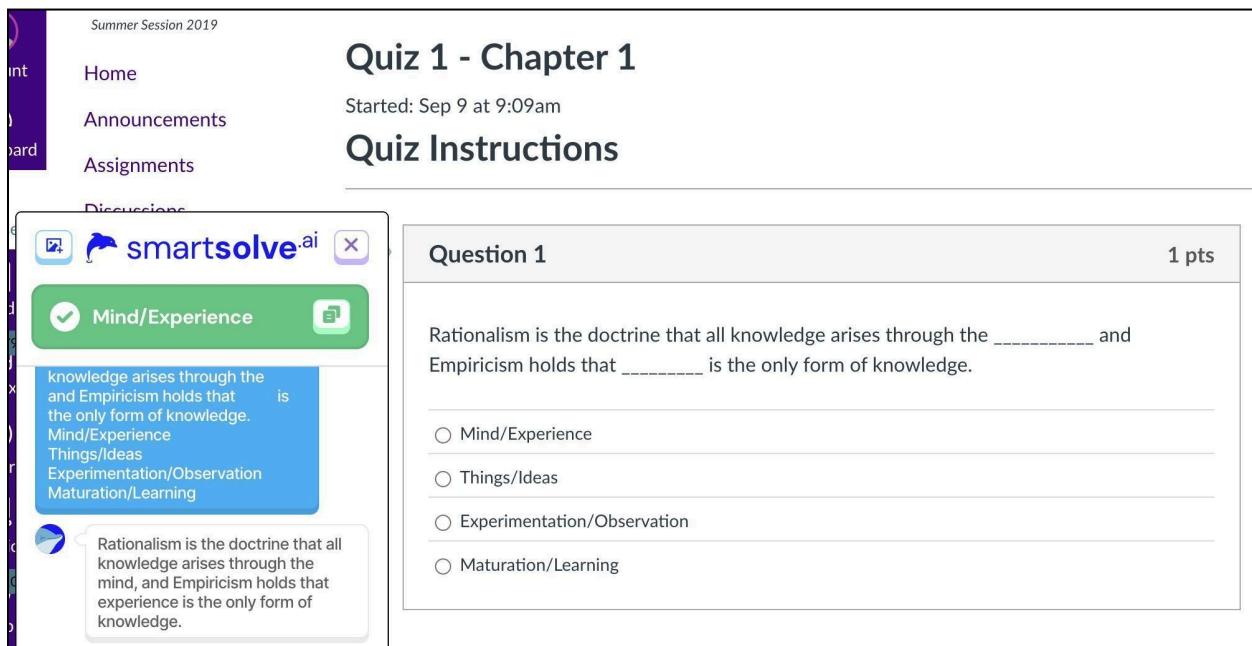
**Figure 2:** Example of Uploading a Mathematics Worksheet to Gauthmath.com (12 September 2024)

The screenshot shows a user interface for Gauthmath.com. On the left, a sidebar lists various tools: Home, Gauth AI, PDF Helper, Writing Helper, Calculator, Resources, and Blog. The main area is titled "Solving Quadratic Functions by Factoring" and contains several math problems. Problem 1:  $x^2 + 3x + 2 = 0$ ; Problem 2:  $x^2 + 6x = -8$ ; Problem 3:  $x^2 + 24 = -11x$ ; Problem 4:  $-30 = x^2 + 11x$ ; Problem 5:  $x^2 + 5x + 9 = 5$ ; Problem 6:  $3x^2 + 10x + 21 = 2$ ; Problem 7:  $x^2 - 6x = 10 - 3x$ ; Problem 8:  $225 - x^2 = 0$ ; Problem 9:  $2x^2 + 11x - 7 = x^2 + 5x$ ; Problem 10:  $14 = 50 + 15x + x^2$ . To the right, a "Solve" panel for Problem 10 shows the AI solution: "Alright, let's solve this quadratic equation step by step". Step 1: Understand the problem. We have a quadratic equation in the form of  $14 = 50 + 15x + x^2$ . We need to find the value of  $x$ . Step 2: Rearrange the equation so that it equals zero. This gives us  $x^2 + 15x + 50 - 14 = 0$ , which simplifies to  $x^2 + 15x + 36 = 0$ . Step 3: Factor the quadratic equation. The factors of 36 that add up to 15 are 9 and 4. So, the factored form of the equation is  $(x + 9)(x + 4) = 0$ . Step 4: Set each factor equal to zero and solve for  $x$ . This gives us  $x + 9 = 0$  and  $x + 4 = 0$ . Solving these equations gives us  $x = -9$  and  $x = -4$ . The "Answer" is "The solutions to the equation are  $x = -9$  and  $x = -4$ ".

**Figure 3:** Example of Gauth Incorrectly Solving an Equation from a Worksheet (12 September 2024)

## AI Tools Can Answer Online Multiple-Choice Questions

Many mathematics tests and quizzes are created in a multiple-choice format to check understanding. As of 2024, more and more teachers are implementing online tests and quizzes for ease of access. While online tests and quizzes can be more convenient, AI tools can now provide answers with a finger click. For example, a tool called SmartSolve AI, <https://smartsolve.ai/>, a Google Chrome extension or iOS app that can be used to answer any electronic multiple-choice question. SmartSolve AI can connect to classroom management sites such as Canvas, BlackBoard, and Google Classroom to answer test and quiz questions without the teacher knowing. SmartSolve AI can answer virtually any multiple-choice question online using screenshots or typing tools. Teachers must be aware that tools like SmartSolve exist, so activities should be done using paper and pencil to encourage students to demonstrate their cognitive skills.



The screenshot shows a Canvas quiz interface for 'Quiz 1 - Chapter 1' started on Sep 9 at 9:09am. The quiz instructions state: 'Rationalism is the doctrine that all knowledge arises through the \_\_\_\_\_ and Empiricism holds that \_\_\_\_\_ is the only form of knowledge.' Below is a list of four options with radio buttons:

- Mind/Experience
- Things/Ideas
- Experimentation/Observation
- Maturation/Learning

On the left, a sidebar for 'smartsolve.ai' shows a 'Mind/Experience' section with the text: 'knowledge arises through the \_\_\_\_\_ and Empiricism holds that \_\_\_\_\_ is the only form of knowledge. Mind/Experience Things/Ideas Experimentation/Observation Maturation/Learning'. Below this, a note states: 'Rationalism is the doctrine that all knowledge arises through the \_\_\_\_\_ and Empiricism holds that \_\_\_\_\_ is the only form of knowledge.'

**Figure 4:** Example of Multiple-Choice Tests being Solved using SmartSolve AI (09 September 2024)

## AI Tools Can Explain the Mathematics in Words

Depending on your selected platform, AI can also provide explanations that could provide reasoning behind accurate mathematical concepts. Thetawise, <https://thetawise.ai/>, is an online AI math tutor advertised as the “most accurate AI tutor” on their homepage (Thetawise, 2024). Unlike other AI platforms, Thetawise’s mission is to “go beyond simply providing answers and help students learn how to solve problems on their own” (Thetawise, 2024, paragraph 1). The focus on tutoring over simply answering the questions means students who use Thetawise can use it to answer questions on homework or tests using mathematical thinking. Using the chat feature, students can select from highlighted prompts, including “Give me the answer,” “I don’t understand,” and “Retry.” Depending on the prompt, Thetawise will also provide suggestions for further exploration, as pictured in Figure 5. In this example, Thetawise provides a mathematically accurate answer with an explanation for the prompt: “There are two ducks in front of a duck, two ducks behind a duck, and a duck in the middle. How many ducks are there?” When asked to expand, Thetawise could also provide an accurate explanation. While Thetawise is advertised as a more mathematically precise platform, it is not a free resource and requires a subscription after the initial trial. This raises questions about the equitability of using AI in academic settings.

👤 You
📝

There are two ducks in front of a duck, two ducks behind a duck and a duck in the middle. How many ducks are there?

👤 Thetawise
🚩

Let's break down the problem step by step:

1. Two ducks in front of a duck: This implies there is at least one duck behind these two ducks.
2. Two ducks behind a duck: This implies there is at least one duck in front of these two ducks.
3. A duck in the middle: This suggests there is one duck that is neither strictly in front nor behind the others, but in the middle.

Given these clues, we can visualize the ducks in a line as follows:

- Duck 1
- Duck 2
- Duck 3

Here's the reasoning:

- Duck 2 is the duck in the middle.
- Duck 1 and Duck 2 are in front of Duck 3.
- Duck 2 and Duck 3 are behind Duck 1.

So, the total number of ducks is three.

Therefore, there are **three ducks**.

Give me the answer ➤
Continue ➤
I don't understand ⓘ
Retry ⚙

Can you explain how you visualized the ducks? ➤

What if there were more ducks added? ➤

Is there a different way to interpret this problem? ➤

**Figure 5:** Example of Thetawise Explaining the Mathematics (29 August 2024)

### Implication for K-12 Mathematics Teachers

Teachers must know they cannot control students' home use of AI tools. While teachers can implement lockdown browsers in schools, internet access should be assumed as standard at home for most students. Teachers should know how students might use these tools and how to spot them. Then, they can use AI to their advantage. For example, teachers can engage students in classroom activities to practice multimodal learning.

So, what can teachers do about AI? We suggest discussing the downsides of Artificial Intelligence tools at the beginning of the school year, including overuse of the technology.

Teachers can show students examples of inaccurate representations, provide examples of how it influences bias, and even have students consider ethical and moral ambiguity around the tool through interdisciplinary lessons (Sawyer & Aga, 2024). By making your students more conscious of these possible issues with the technology, they will become more informed users of AI tools.

Also, rather than altogether banning AI in your classroom, teachers could instead find a way to integrate it during class periods. For example, teachers could create a lesson plan where students must analyze and critique the AI responses for accuracy. This would teach students to practice critical thinking and be the authorities of their mathematics understanding. Ultimately, we want to teach our students the value of problem-solving and using their cognition to solve problems in the world. Rather than fearing new technology, educators can take control by teaching through a critical lens to give their students back the power of their learning.

## References

Cho, W. (28 December 2023). *The New York Times brings receipts copyright lawsuit against OpenAI*. Hollywood Reporter.

<https://www.hollywoodreporter.com/business/business-news/new-york-times-brings-receipts-copyright-lawsuit-openai-1235775781/>

Mashup Math. (2024). *Solving quadratic functions by factoring*.

<https://www.mashupmath.com/s/Solving-Quadratic-Functions-by-Factoring-A.pdf>

Sawyer, A. G. (2024). Artificial Intelligence chatbot as a mathematics curriculum developer: Discovering preservice teachers' overconfidence in ChatGPT, *International Journal on Responsibility*: 7(1). Article 1. DOI: <https://doi.org/10.62365/2576-0955.1106>

Sawyer, A. G. & Aga. Z. G. (2024). Counterexamples to demonstrate the Artificial Intelligence chatbot's lack of knowledge in the mathematics education classroom. *Associate of Mathematics Teacher Educators' Connections*. Retrieved from:

<https://amte.net/sites/amte.net/files/Connections%20%28Sawyer%29.pdf>

Thetawise. (2024). *About*. <https://thetawise.ai/about>

Wu, G. (2023, September 17). *8 big problems with OpenAI's ChatGPT*. Make Use Of.

<https://www.makeuseof.com/openai-chatgpt-biggest-problems/>



## Submissions Solicited For PCTM Magazine

Since the 1990's, the Pennsylvania Council of Teachers of Mathematics (PCTM) has produced the PCTM Magazine for our members. Our mission is to promote mathematics education in Pennsylvania. In the magazine we accomplish this by publishing edited articles by leading authors and local news from around the state. PCTM is committed to improving mathematics instruction at all levels. We place an emphasis on classroom activities that are aligned to the Pennsylvania Core State Standards and the NCTM Principles and Standards for School Mathematics.

You are invited to submit articles for consideration for publication in the PCTM Magazine. This publication provides an excellent opportunity for you to share your ideas with the ever-growing number of colleagues dedicated to improving mathematics education in Pennsylvania. Any topic of interest to teachers of mathematics, especially K-12 classroom teachers in Pennsylvania, is suitable subject material. All readers are encouraged to contribute articles and opinions for any section of the magazine. Teachers are encouraged to submit articles for Voices From the Classroom, including inspirational stories, exemplary lessons, or management tools.

Original artwork on the cover is another way teachers may contribute. We publish the magazine two times each school year, in the fall and spring.. Our website has several archives of journals in PDF format. Please see <https://pctm.org/magazines/> if you wish to view prior issues.

**Deadline for submissions:**  
**Spring, April 1**  
**Fall, October 1**

### **Author Guidelines:**

**Manuscript Format:** Manuscripts should be double-spaced, with 1-inch margins on all sides, typed in 12-point font and follow the APA 6th Edition style guide. Manuscripts should be submitted in Microsoft Word. If you have a picture or graphic in the text, please include the original picture(s) in a separate file. A cover letter containing author's name, address, affiliations, phone, email address, and the article's intended audience should be included in the email.

**Manuscript Submission:** Manuscripts should be submitted electronically as an e-mail attachment to [pctm.editor@gmail.com](mailto:pctm.editor@gmail.com). Receipt of manuscripts will be acknowledged. After review by the editors, authors will be notified of a publication decision.

The current co- editors are Daniel R. Ilaria, Karise Mace & Xiangquan (James) Yao who may be reached at [pctm.editor@gmail.com](mailto:pctm.editor@gmail.com).