Laurel Highlands Mathematics Alliance

Mathematics **E**ducation and **T**eacher **E**xchange **R**eport

Fall 2014

affiliated with NCTM/PCTM

President's Message

For whoever has will be given more, and they will have an abundance. Whoever does not have, even what they have will be taken from them. (Matthew 25:29)

"The Matthew effect." Sociologist Robert K. Merton coined this term when he drew attention to the disproportionate credit renowned scientists receive for work done in collaboration with others or in comparison to lesser known scientists who have produced equally good work (1968). This negatively influences not only individual scientific careers and the allocation of resources, but the world of science more generally by limiting potentially valuable scientific ideas from gaining traction. It is hard to dispute that, more often than not, institutional affiliation translates to privilege (or lack thereof). At the time that Merton reported his research, six top tier universities (Harvard, Berkeley, Columbia, Princeton, California Institute of Technology, and Chicago) produced 22 percent of the doctorates in the physical and biological sciences but a staggering 69 percent of Ph.D.'s who went on to become Nobel laureates.

In *Outliers*, Malcom Gladwell (2008) challenges the widespread notion that individual success is based on intelligence and ambition. He asks us instead to carefully examine what we are "born into," – our cultural and family legacies as well as just plain "dumb luck." Gladwell points to a roster of elite Canadian hockey players to illustrate a striking example of hidden accumulated advantage. The cutoff date for junior hockey eligibility is January 1, favoring players born in January. With an initial advantage of physical maturity over a player born in, say, November, the slightly older player will likely receive more playing time. This translates into further opportunities—invitations to play in more competitive leagues, all-star play, more ice-time, and better coaching—all the way up the line. In the end, rosters of elite hockey players have a disproportionate number of players whose birthdays fall in the first half of the year.

In this Issue

The Matthew effect has been useful in describing educational phenomena as well. Keith Stanovich (1986) highlighted rich-get-richer and poor-get-poorer patterns in reading achievement. Better readers are exposed to more written language than poor readers. Consequently, they expand their vocabularies and knowledge bases. As students transition from learning to read to reading to learn, the academic chasm between the reading "haves" and "have nots" grows ever wider.

The core concern emerging from the Matthew effect is that of untapped human potential. As Merton noted, "These social processes of social selection that deepen the concentration of top scientific talent create extreme difficulties for any efforts to counteract the institutional consequences of the Matthew principle in order to produce new centers of scientific excellence” (p. 62). Forty years later, Gladwell continues to challenge us to imagine how massive social reorganization might unlock an equal chance at success for those not endowed with initial advantages.

With the exception perhaps of parenting, there is no greater vocation than teaching when it comes to the nurturing of human potential. Those who teach mathematics are already acutely aware of the gatekeeping nature of the subject—success in school mathematics translates to college admittance, which in turn translates to economic security and so on. As such, the Matthew effect seems a particularly promising point of departure for critical examination of mathematics teaching and learning.

As we begin a new school year, there is no better time to reflect on the mathematical advantages we bestow on our students. At the individual level, one might consider questions such as: Which students regularly have access to cognitively demanding mathematical tasks? Which students regularly have opportunities to engage in authentic mathematical practice (such as those suggested in the Standards for Mathematical Practice)? Which students regularly have opportunities to discuss and communicate mathematics in the classroom? At the school and district level, it is well worth deliberating the merits of ability grouping. How many doors close with each middle-level math placement? Are placement policies contributing to “borderline casualties”? As Jo Boaler (2009) has wisely observed, “In many cases, students are assigned to groups on the basis of a single test score with some students missing the high groups because of one point. That one missed point, which students may have scored on another day, ends up limiting their achievement for the rest of their lives” (p. 114). And finally, how might we, as a mathematics teacher professional organization, best champion mathematics teaching and learning so that no human potential goes untapped?

May the new school year be one of mathematical abundance (and accumulated advantages) for *all* students.

Mathematically yours,

Kate Remillard
LHMA President

Boaler, J. (2009). *What’s math got to do with it? How parents and teachers can help children learn to love their least favorite subject.* New York: Penguin Books.

Gladwell, M. (2008). *Outliers*. New York: Little Brown and Company.

Merton, R.K. (1968). The Matthew effect in science*. Science, 159* (3810), 56-63.

Stanovich, K.E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly 21*(4), 360-407.

LHMA Membership

The LHMA membership year runs from September to August. We provide the opportunity to renew membership for the next year on the registration forms for the Spring Mini Conference. You may also print an application from the LHMA website (http://francis.edu/laurel-highlands-mathematics-alliance/) and mail it to:

Jackie Baird
University of Pittsburgh - Johnstown
450 Schoolhouse Road
141 Krebs Hall
Johnstown, PA 15904

PCTM/NCTM Report

Nina Girard, University of Pittsburgh at Johnstown

The 63rd Annual PCTM Conference will be held November 5-7, 2014 at the Holiday Inn Harrisburg East, Hershey. Guest speakers will be addressing STEM education, PA Core Standards, and Keystone testing. With close to one hundred sessions there are topics for all levels of mathematics teachers wanting to take ideas back to their classrooms. Registration for the conference and hotel reservations is now open and can be accessed at http://www.pctm.org/conference-2014.html

At a time when district professional development is being redefined, PCTM will also be implementing a major change to its conference dates. The 64th Annual Conference will move to early August 2015 in Lancaster, PA. With so many districts moving towards a trade-time professional development system, August will be the perfect time for teacher to come to the PCTM Conference without missing a day or two with their students. Further updates on this change will be available on the PCTM website.

There are two vacancies for a Western PA Regional Representative on the PCTM Executive Board. This is your chance to become involved as a leader in math education across the state. If you have an interest in serving on the PCTM Board in this capacity, please contact PCTM President Marian Avery (mavery077@gmail.com) for more information.

Have you heard about NCTM's newest resource publication? *Principles to Action: Ensuring Mathematics Success for All* was released this past April. "In *Principles to Actions*, NCTM sets forth a set of strongly recommended, research-informed actions for all teachers, coaches, and specialists in mathematics; all school and district administrators; and all educational leaders and policymakers" (NCTM, 2014, p. 4). NCTM has provided our community with a set of mathematics teacher practices that research has indicated have a positive effect on students' learning in order to address what it will take to turn the opportunity of the Common Core into reality into every classroom, school, and district. For more information on this publication or to order a copy, consult the NCTM website: http://www.nctm.org/PrinciplestoActions/

Respectfully submitted,

Nina Girard
NCTM/PCTM Representative

SAVE THE DATE

November 5-7, 2014
2014 PCTM Annual Conference
Harrisburg, PA
http://pctm.squarespace.com/

February 14, 2015
Mathcounts (Johnstown chapter)
University of Pittsburgh at Johnstown
almiller@pitt.edu

March 21, 2015
LHMA 2nd Annual Mathematics Educators Mini-Conference
University of Pittsburgh at Johnstown

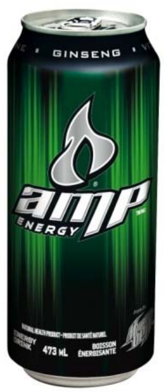
April 10-11, 2015
MAA Allegheny Mountain Section Meeting
Washington & Jefferson College
Washington, PA

April 29, 2015
Try-Math-A-Lot
University of Pittsburgh at Johnstown

AMP Energy Drink Gives Modeling Standard a Ten Hour Boost

Julie Sipe, Central Cambria High School, and Monica Emerson, Blacklick Valley

The Common Core State Standards Initiative defines modeling as the process of selecting and utilizing appropriate mathematics to analyze and understand problems in order to make the best decision possible (CCSST, 2010). As mathematics teachers, modeling is essential in preparing and teaching each lesson. When we teach our students a new concept, we demonstrate exactly what we expect them to do and how we expect it to be accomplished. However, we should also see the value in allowing our students to develop certain concepts on their own. In taking a hands-off approach as teachers, we compel the students to find and practice their own problem-solving strategies. They learn the importance of persevering through a problem, making sense of math to identify mistakes, and altering their strategies according to those mistakes. This idea of letting our students "mathematically play" was the basis for the task that we created as our participation in the 2013-2014 MSP-RAMP Program (Mathematics and Science Partnership-Reflection and Application of Mathematical Practice).

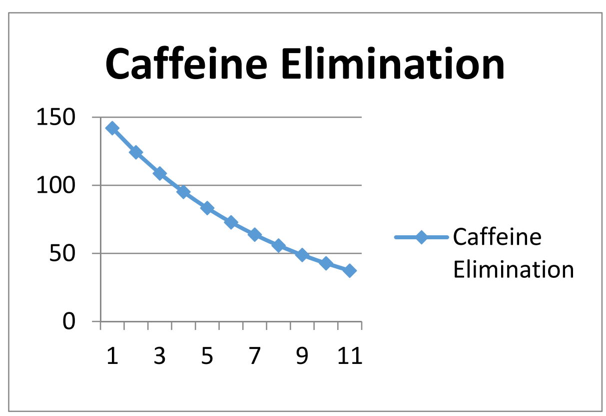


The goal of our task is to take a specific problem, discover a pattern in solving it, and create a formula that would be generalized to the exponential growth and decay formula. Unlike so many lessons that simply introduce the formula and show how to use it, we wanted to challenge our students by letting them solve the problem the "long way" and motivate them to find a formula that would make solving easier. This all led to the following question that we posed to our students without any other concrete guidance:

> "The average teen can eliminate approximately 12.5% of the caffeine (they consume) from their system per hour. How many mg of caffeine (to the nearest hundredth) from an Amp Energy Drink (142 mg) would be remaining in your body after 10 hours? Represent the problem and your solution using two different types of models (graph, table, verbal, algebraic formula, or pictorial representation)."

As we observed our students working in small groups, we both found it very difficult to allow them to struggle through their work and make mistakes, but also very rewarding to see them creating and explaining their own models for the problem.

Despite some stumbling blocks in the process, all student groups answered the question correctly - approximately 37 mg would still be in a teen's body after 10 hours. Most groups in our classes used the table and graph to complete the task. Through the graph model (shown at the right), students could visually see the relationship between time (*x*-variable) and the amount of caffeine in the body (*y*-variable). The table model demonstrated the fact that the caffeine was not leaving the body at a constant rate. Both models led to great questions and discussions about the type of relationship: Was the graph linear or quadratic? Did it have any characteristics that they have seen before in a graph? Will the caffeine ever be completely eliminated from the body? Many students thought that the graph resembled "half of a parabola," which led to the conclusion that some sort of exponent should be present in the formula, noting it is not an exponent of 2 since it is not quadratic.



The few groups that decided to model the problem with an equation discovered that the process of subtracting 12.5% of the caffeine in order to eliminate it from the body is equivalent to 87.5% of the caffeine still remaining in the body. These students were able to take a two-step, time-consuming, and somewhat tedious solving process, and condense it to one step. By sharing this discovery with the class, combining it with the idea of an exponent, and using a modified version of their table of time vs. caffeine (see table on next page), we modeled the situation as a class with the following equation: $A(h) = 142(.875)^h$. Discussion of the meaning behind each variable resulted in the following discoveries: the number 142 is representing the initial value, hours are the specific unit of time used for this problem, and .875 originates from a subtraction from 1. Finally and collaboratively, we generalized the variables and values to derive the exponential growth and decay formula: $A(t) = A_0(1 \pm r)^t$.

Time (hour)	0	1	2	3	4	h
Caffeine (mg)	142	124.25	108.72	95.13	83.24	A
Caffeine (mg)	142	$142(.875)^1$	$142(.875)^2$	$142(.875)^3$	$142(.875)^4$	$A_0\ (1 - r)^h$

Feedback given from our students revealed that they generally enjoyed the challenge of deriving the formula, despite the struggles along the way. In the process of solving, our students were doing mathematics instead of simply using procedures, and modeling was an essential part of completing the task. Since various models were used, students were better able to understand what the different variables of the formula represent. By deriving the formula themselves, our students were not simply memorizing an equation given to them, but they were developing a process that they could apply to similarly modeled situations, such as half-life and compound interest. Throughout the creation of our task and the revise-and-reflect process, an underlying goal was to teach our students how they can use different models to represent the same problem. It is our hope that they can extend the problem-solving strategies they learned in this task to other problems in math, in other subjects, in the classroom, and outside of the classroom.

Common Core State Standard Initiative (CCSSI). 2010. Common Core State Standards for Mathematics. Washington, DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers. http://www.corestandards.org/wp-content/uploads/Math_Standards.pdf

Worthy Websites for Math Teachers

Mathematics Assessment Project ASSESSING 21ST CENTURY MATH MAP: An Overview for Teachers	Mathematics Assessment Project The Mathematics Assessment Program (MAP) aims to bring to life the Common Core State Standards (CCSSM) in a way that will help teachers and their students turn their aspirations for achieving them into classroom realities. MAP is a collaboration between the University of California, Berkeley and the Shell Center team at the University of Nottingham, with support from the Bill & Melinda Gates Foundation. The team works with the Silicon Valley Mathematics Initiative and school systems across the US and UK to develop improved assessment.
youcubed	YouCubed The new movement to revolutionize math teaching and learning. YouCubed is a nonprofit providing free and affordable K-12 mathematics resources and professional development for educators and parents.

Book Review

This book review will also appear in the Fall 2014 PCTM Magazine

> Have you read a book that fellow math teachers would appreciate? Please send a review for inclusion in the Spring 2015 newsletter by mid-January to victoriaczarnek@gmail.com.

What's Math Got to Do with It? How Parents and Teachers Can Help Children Learn to Love Their Least Favorite Subject

by Jo Boaler
Penguin Books, 2009
273 pages
ISBN: 978-0-14-311571-7

Reviewed by Katherine S. Remillard

In *What's Math Got to Do with It? How Parents and Teachers Can Help Children Learn to Love Their Least Favorite Subject*, Stanford math specialist Jo Boaler delivers an all-encompassing manifesto on U.S. mathematics education. Drawing from a wide swath of research, Boaler, a driving force behind math reform in the U.S and beyond, adeptly diagnoses the crippling ills of our classrooms, before prescribing a bold yet sensible path forward.

Boaler opens by pinpointing the glaring discrepancy between the nature of mathematics as a discipline and the nature of school mathematics. Whereas authentic mathematical practice is characterized by problem solving, problem posing, guessing, collaborating, and using a range of representations, school mathematics is often reduced to an endless "ladder" of rules and procedures memorized and practiced in isolation. In particular, students are expected to learn *without thought* (when replicating the methods of the teacher's examples on sets of near-identical questions), *without talking* (when working individually seated in rows), and *without reality* (when they are asked to suspend their real-world knowledge and solve problems with ridiculous make-believe pseudocontexts). Boaler argues, "The math that millions of Americans experience in school is an impoverished version of the subject and it bears little resemblance to the mathematics of life or work or even the mathematics in which mathematicians engage" (p. 15-16).

From here, Boaler fearlessly tackles the (odious) 800-pound gorilla in the room—testing. Hardly mincing words, she calls the testing system in the U.S. "disastrous." "The elimination of powerful learning experiences because they cannot be reduced to testable knowledge is damaging education in America" (p. 88). In particular, she points to the overreliance on multiple choice questions rather than written response; the focus of tests on procedures rather than thinking, reasoning or problem solving; the problem that standardized questions test language as much as they do mathematics; and the harsh and comparative reporting of scores.

Yet, for teachers who feel constrained by standardized tests, but believe that it is important to teach children to learn to think and reason and solve complex problems, there is another way—one which they *can* control. "Inside classrooms there is room for even more improvement and the 'assessment for learning' approach has been designed to revolutionize the way assessment is used *inside classes* [italics added]" (p.97). Assessment *for* learning is fundamentally distinct from assessment *of* learning. The former provides learners with feedback on what they need to improve in relation to the content. The latter simply quantifies how well they have done in relation to others. Teachers using assessment *for* learning prioritize communicating about what is being learned, making individual students aware of where they are on the path to success and giving clear advice about how to become more successful.

As if the pedagogical merits of assessment *for* learning weren't enough, it has also proven to be highly efficient. Whereas initiatives to raise teacher knowledge or cut class size are costly and result in marginal increases in student learning, assessment *for l*earning is relatively inexpensive and has been found to double the speed of learning. Along the way, the author summarizes, "Assessment for learning transforms students from passive receivers of knowledge to active learners who regulate their own progress and knowledge and propel themselves to higher levels of understanding" (p. 105).

In addition to testing, Boaler also challenges the orthodoxy surrounding ability grouping. Arguing that this practice perpetuates low achievement, she points to the chilling statistic that in England “88 percent of children placed into ability groups at age four remain in the same groupings until they leave school” (p. 121). In the U.S., the tracking decisions made by middle school mathematics teachers are especially problematic. Students placed in lower-level mathematics classes in the 7th grade rarely have the opportunity to complete the full slate of high school math courses, thus putting them at a disadvantage for college admittance. These observations are hardly new to the debate. What Boaler uniquely adds is a persuasive argument for mixed-ability grouping for *all* students—including those students traditionally identified as low- and high-achieving.

But the success of mixed-ability grouping hinges on mathematics classrooms looking, sounding and “feeling” fundamentally different from the traditional American math class script. Two conditions are necessary for this realization. First,

> Students must be given open work that can be accessed at different levels and taken to different levels. Teachers have to provide problems that people will find challenging in different ways, not small problems targeting a small, specific piece of content. (p. 118)

These are characteristics of the most mathematically interesting problems and hence are naturally engaging for students. Second, it is not enough just to group students together, they must be taught to work well and respectfully together. When we reach a point in classrooms where “different strengths are seen as a resource rather than a point to ridicule, then children are helped by being able to achieve at high levels and society is helped through the development of respectful, caring young people” (p. 120).

Chapter 7, *Key Strategies and Ways of Working,* should be required reading for every pre-service teacher, practicing teacher and administrator. Here, Boaler differentiates between achieving and failing students in their ways of working in mathematics. The distinction has nothing to do with hard work or laziness. Rather, achieving students learn how to decompose and recompose numbers at an early age, resulting in flexible mathematical thinking. Moreover, this initial flexibility allows for a lifetime of mathematical compression. That is, after an initial struggle with the methods and ideas of a new concept followed by adequate practice, achieving students compress what they know and move on to a next, more difficult concept. Before long, executing the concept becomes automatic.

In contrast, low-achieving students are not compressors of mathematical ideas. Instead, they experience mathematics as a never-ending ladder of rules and procedures to be memorized and carefully reproduced. In other words, they have the wrong model of mathematics. And what do we do time and time again with low-achieving students? We reinforce this impoverished view of mathematics by providing remediation consisting of procedural drill. What these students really need is someone to teach them authentic strategies for working flexibly in mathematics—they need help developing number sense. Fortunately, Boaler reminds us that it is never too late for students to learn to think in these ways, provided that the right teacher is there for them.

What’s Math Got to Do with It? is a refreshing read for teachers (and parents) who are disillusioned, disheartened, and/or exhausted by working within the current system. Boaler’s vision for a better mathematical future is one that teachers can believe in. The book should serve to bolster teachers’ confidence in taking the calculated risks needed to transform the classroom experience from one of fear and boredom to that of excitement and interest.

WE NEED YOU!

LHMA will soon be seeking nominations for the following officer positions: President Elect and Treasurer. A call for nominations will be made via email in early 2015. Please consider nominating someone or yourself for one of the positions. The presidency position is a 4-year commitment (President Elect 1 year, President for 2 years, and Past President 1 year), and the treasurer is a 2-year position. More information regarding the positions can be obtained from Nominations Chair, Nina Girard (nina@pitt.edu). We need your help and interest to sustain viability of our organization!

Grading the AP Calculus Exam

Victoria C. Czarnek, University of Pittsburgh at Johnstown

Interacting with students and watching their eyes light up when our brilliant explanations help them understand a tricky concept: those are the aspects of teaching the typical teacher finds rewarding, not grading. Grading can be tedious, at best. Why would anyone volunteer to devote seven consecutive days, precious summer vacation days far from home, to sit with 850 strangers while grading only one question on about 400 exams per day?

Highly qualified math teachers from all over the country wait for years for the opportunity to do just that as graders (called *readers*) of Advanced Placement Calculus Exams, eagerly hoping to be invited to repeat the experience year after year. Often described as one of the best professional development experiences possible for a mathematics teacher, Educational Testing Service (ETS), the organization that administers AP Exams for College Board, has succeeded in making a week spent grading not only professionally rewarding, but fun.

The first feeling most new graders, known as *acorns* in the AP world, have is not enjoyment, but concern about being able to grade in a way that is both fair to the students and consistent with the other graders. The well-thought-out structure is quickly apparent from the start, however. Before beginning on a question, all readers attend a training session for the roughly 400 people responsible for grading it. A Question Leader (QL), who has studied many exams and is familiar with typical student errors, distributes a detailed rubric and discusses what, precisely, must be part of an answer to earn points.

After the training session, readers take their rubrics to their assigned group of about 18: eight pairs of readers (Table Partners) and two Table Leaders. Of course it is impossible to anticipate the creative minds of students, so seeing an answer that doesn't neatly fit the rubric occurs often. In such a case, a reader is expected to discuss it with his/her Table Partner. If the pair can't figure out the appropriate number of points to reward, their next course of action is to consult one of the Table Leaders, who have the final say in the appropriate number of points to award.

Table Leaders have another role: not only do they have the final say in determining how to correctly score, they also make sure that the rubric is being followed by *back-reading* the exams scored at their tables. If a Table Leader thinks a question merits a different number of points than granted by a reader, a gentle discussion ensues. These discussions occurred with even the most experienced readers, and instilled a deeper understanding of the nuances of grading each problem and a confidence that consistency is, in fact, being maintained.

As that confidence builds, it is easy to recognize how professionally rewarding the experience is. Clearly it is satisfying to be surrounded by people who understand limits and associate the word "series" with something other than Netflix, and it is enlightening to have the opportunity to discuss textbooks, online homework systems, and effective teaching methods with math teachers from around the country. Aside from the quick camaraderie formed by shared interests, readers also gain valuable professional insights they can carry to their classrooms.

To be able to grade totally impartially is a worthy goal for all teachers. In spite of our best intentions, it can be a struggle to discern what a student means versus what s/he writes when grading, especially when grading a student whose personality and abilities we know. When grading thousands of AP exams, all written by someone else's students, the temptation to give the benefit of the doubt vanishes. Being a more neutral grader is bound to be a result of this experience.

Clearly having graded AP Exams will make AP Calculus teachers better qualified to guide their students to success on the exam. Although scoring guidelines for past exams are available on the AP website[1], spending a week analyzing and discussing acceptable answers is invaluable. About half of the graders have never taught AP Calculus, however, as they teach at the college level. After the grading experience, they have a much better understanding of the background of students with a "4" or a "5" on the Calculus AB Exam. Not only are such students really ready for Calculus II, they may find much of the material in Calculus II to be familiar.

So where does the fun come in? It is an incredibly friendly group, making it easy to meet people with whom to eat in the dining hall and explore Kansas City. Conversations included non-mathematical topics, such as book recommendations and music. Optional professional activities and a lounge area for socializing are available in the evenings, and there was a 5K for runners and a chorus for singers. A typical description of the week includes a comparison to summer camp!

Next year's Calculus AP Exam will be graded June 2-8 in Kansas City, Missouri. High School teachers who currently teach an AP class and have three years of experience doing so, and college-level faculty who have taught at least one AP level class in the past three years are invited to apply[2]. All expenses and a stipend are paid to those fortunate enough to become readers.

[1] http://apcentral.collegeboard.com/apc/members/exam/exam_information/1997.html

[2] http://apcentral.collegeboard.com/apc/public/homepage/4137.html

Laurel Highlands Mathematics Alliance (LHMA), an affiliate of the Pennsylvania Council of Teachers of Mathematics (PCTM - http://pctm.squarespace.com/) and the National Council of Teachers of Mathematics (NCTM - http://www.nctm.org/), gives mathematics educators the opportunity to grow professionally and interact with colleagues in Bedford, Blair, Cambria, Fulton, Huntingdon, and Somerset Counties. As such members can have a direct impact on state and national policy decisions in areas of certification, curriculum changes, and graduation requirements. Information about membership can be found at http://faculty.francis.edu/LHMA/

Laurel Highlands Mathematics Alliance
Officers and Executive Board

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*Interested LHMA members are encouraged to consider filling vacant positions. For more information, please contact Dr. Nina Girard at nina@pitt.edu.

To submit articles or information about upcoming events for the Spring 2015 issue (deadline: mid-January), please contact Victoria Czarnek at vcc1@pitt.edu.