



2014 Focus Issue:  
**Building a  
Math Village:**  
Developing Partnerships  
among School, Home,  
and Community

# WOW! Mathematics Convention: A Community Connection

By Rebecca R. Cavazos

“**B**y asking questions, noticing patterns, and just plain thinking about things that make people say ‘Wow!’ humanity adds every day to the list of amazing things we’ve figured out. There are lots of mysteries out there that no one understands, and still more that no one even knows about yet. You never know what new knowledge will come in handy in the future, or who will use that knowledge differently than ever before to discover something new. So keep up the great work, keep your eyes open for amazing things in school and all around you, . . .” (from an e-mail to students by Andrew Marble of the National Solar Observatory).

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**A math professor, a biologist, a literacy professor, a chemist, a statistician, and an engineering student walk into a fourth-grade classroom—and students are encouraged to tackle difficult math challenges.**



PETER SHAPLEY (2)

Cavazos invited eleven community STEM experts to a classroom “math convention.” After introducing them to her fourth graders, Cavazos asked the visitors to talk about how they use mathematics in their jobs.

Dr. Marble (the father of a student in my class), was one of our community participants at our First Annual WOW! Mathematics Convention for my fourth-grade class at Borton Magnet School in Tucson, Arizona. Also joining us were a math professor, a biologist, a literacy professor, a chemist, a statistician, and an engineering student as well as our school principal and computer lab technician, both of whom are math enthusiasts. This article details how certain mathematical “discoveries” that my fourth graders made were recorded throughout the year and then investigated intricately within a “convention” involving STEM experts from the community. My intent is to share with you one way that I successfully integrated the community into my classroom, which ultimately benefited community members and students alike.

We called on STEM experts in our community to help my fourth-grade students figure out the “why” behind certain patterns in numbers that they noticed throughout the year. As we progressed through our Investigations in Number, Data, and Space curriculum (TERC 2008), I would take note of some of the discoveries that students made. The students were accustomed to looking critically at mathematical circumstances as well as taking risks in communicating

their ideas. They know that the mathematical standards of Reasoning and Proof, Problem Solving, and Communication (as defined by NCTM 2000) are an integral part of learning in our classroom. The mathematical discourse orchestrated in the classroom on a daily basis is evidence of my belief in the importance of the Standards for Mathematical Practice (SMP) in the Common Core State Standards for Mathematics (CCSSM) (CCSSI 2010). I regularly ask my students to explain their thinking, to prove their answers, and to justify their reasoning. I also ask students to listen to others’ reasoning, to add to it, to agree or disagree with it, and then to justify their position.

### Yearlong discoveries

The first discovery that surfaced was Bruno’s. When we initially explored factors and multiples, he studied my classroom hundred chart when the multiples of three were covered by a colored transparency and noticed that when he reversed the digits in the multiples of three, the new number was also a multiple of three. I had honestly never thought about this, so my reaction was, “Wow, you’re right!” We took some time to see if it really worked for all multiples of three and to try to understand why. It worked for multiples through ninety-nine, but we never got to the answer for why. I decided to record our investigation on construction paper, call it “Bruno’s WOW!” and leave it posted in my classroom for further investigation. This prompted



Students in this classroom are accustomed to a safe environment for academic discourse where they explain their thinking, prove their answers, listen to others’ reasoning, add to it, agree or disagree with it, and then justify their reasoning.

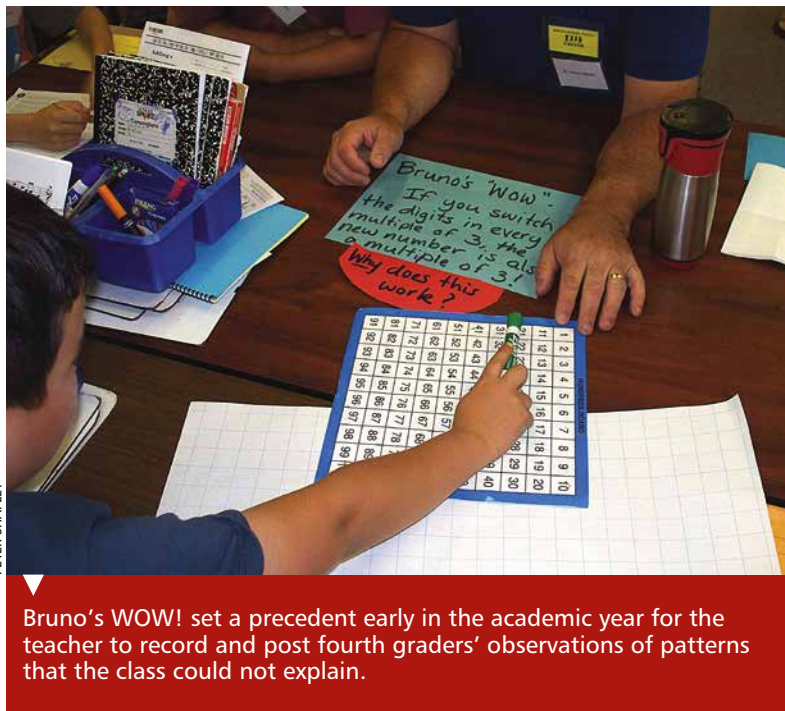
my students to look for WOWs throughout the rest of the year. A WOW! became an observation by a student of a pattern that works in multiple cases but could not be readily explained in the timeframe of the lesson or within students' (and sometimes the teacher's!) mathematical abilities. Naming WOWs with students' names was great incentive for them to look for these functional relationships in math. We subsequently accumulated a total of four WOWs. We posted these throughout the year, and students who finished their math work early were encouraged to explore the WOWs to determine why they work.

### A math convention

Toward the end of the school year, after completing the state testing, we decided to hold a WOW! Mathematics Convention to see if mathematicians in the community could come in and help us solve the "whys" of our WOWs. I put out a memo to parents. I had several University of Arizona parents of students in my current class. I have also hosted many student teachers and preservice teachers in my classroom during the past few years, so I connected with the education professors at the university. I invited a student majoring in engineering (my son), our principal, and our computer lab technician. Eleven adult math supporters worked with twenty-three student math fanatics who were ready to problem solve. I also had secured a cheat sheet from a retired physicist living in California. He had wanted to participate via Skype, but our technology deficiencies prohibited his live participation. However, he emailed written explanations, mostly algebraic, to explain why the WOWs work.

### Group discourse

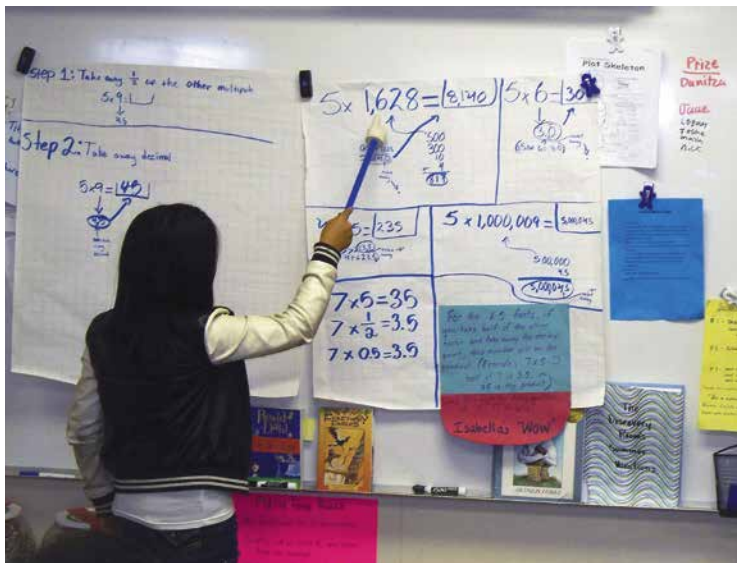
After introducing our STEM guests and having them tell a little about their jobs and how they use math at work, I divided the class into four groups and assigned a different WOW! to each. The adults went to the group that had the WOW! with which they were most comfortable. I made available hundred charts, three-hundred charts, number lines, white boards, and chart paper. I had planned for the convention to last about an hour, but the mathematics discourse was still going strong after an hour. Most students were completely engaged the entire time. I had



Bruno's WOW! set a precedent early in the academic year for the teacher to record and post fourth graders' observations of patterns that the class could not explain.

wanted time for the groups to share their discoveries, so I decided to encourage each group to wrap up their discussions and plan how they would present their findings to the rest of the group. Students then shared what they had discovered and were much invested in their work as they attempted to explain the reasoning behind their WOW.

A pattern that works in multiple cases but could not be readily explained became a classroom WOW! preceded by the name of the student who first made the observation.



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Marciel explained why, when multiplying by fives, you can take half of the other factor, delete the decimal point, and find the product. Almost every student in this group was able to explain as well.

To show the type of rich dialogue and deep thinking that took place, I will attempt to provide a synopsis of what transpired in a couple of the groups. Isabella's WOW! was stated as such:

For the times-five facts, if you take half of the other factor and take away the decimal point, this number will be the product. (E.g.,  $7 \times 5 = n$ . Half of 7 is 3.5, so 35 is the product.)

Students in this group were primarily coached by the engineering student and the biologist. They started out by testing different smaller numbers to prove that this theory would hold true for all numbers. The students were excited to show the adults that it was a sound theory. The adults encouraged them to list multiples of five in an organized way. The adults also prompted students to think about the multiples of ten and find the relationship between the two lists. They asked the students what they knew about five and ten. This discussion led to the students' understanding of why you can take half of the number being multiplied by five, eliminate the decimal point, and have the product. Students were eager to try much larger numbers. They called me over at one point to exclaim that their theory would work even for infinity! But they went on to prove for me that

it worked for  $5 \times 1628$  by halving the factor. The answer, they stated, was 814.0 because "we're using decimals."

Marciel stated confidently, "You just take away the decimal, and you have your answer!"

The group also proved that it worked for 1,000,009, which was really stretching their field of number sense. At this point, the group had a large piece of chart paper with lots of figuring on it. The adults helped them create an organized chart of the steps they had taken to explore their WOW! This exercise provided reinforcement for those in the group who might have still been unsure about their findings. When sharing with the class, Isabella began with an explanation of what she was thinking when she came up with her WOW! and the fact that it works for all multiples of five. With a visual representation, Marciel continued to confidently show how it works:

$$\begin{aligned} 7 \times 5 &= 35 \\ 7 \times 1/2 &= 3.5 \\ 7 \times 0.5 &= 3.5 \end{aligned}$$

The group was asked, "Why does it work?" and Josue responded that five is half of ten, and ten is the basis of our number system. Although he did not exactly articulate the relationship between multiplying by ten and then dividing by two in the presentation, it was clear that the group had at least a partial understanding of the base-ten system. They demonstrated on their chart that their theory worked even for larger numbers. Almost every student who participated in this group felt confident enough in their mathematical abilities to explain their findings without the help of the adult mathematicians. Plus, they created a practical application of decimal and fraction use and the need to multiply larger numbers. The fourth-grade Investigations curriculum does not go much beyond multiplying double-digit numbers.

In contrast, Bruno's group was unable to explain their WOW! in the time provided. They were encouraged by the STEM expert working with them to look at the difference between the 2 two-digit numbers that were multiples of three. For example, eighteen and eighty-one are both multiples of three. The difference between these two numbers is sixty-three, which is also a multiple of three. This, they

found, works for all two-digit multiples of three. When they began to explore three-digit multiples of three, something new happened. The *sum* of the digits in such a number was always a multiple of three. They also surmised that these rules apply for negative numbers and thus created a negative hundred chart and taped it to the positive hundred chart to prove their theory. They were able to continue the diagonal pattern of multiples of three that they had observed on the hundred chart onto the negative hundred chart. They also discovered that the negative hundred chart somewhat mirrors the positive chart, as happens on a number line. In class, we had explored negative numbers only using a number line. Needless to say, this group explored a lot of math. Bruno's group members were unable to put together much of a visual to explain the WOW! but they were able to demonstrate the negative and positive hundred charts and what happens with the digits in a multiple of three. They delved into some practical algebraic concepts (using letters as placeholders of numbers) when demonstrating what happens with three-digit multiples of three. Because of the number of concepts with which this group was able to go into depth, I believe the "convention" format was just as valuable as it was to the other groups, who *could* explain their WOWs.

After the groups had shared their discoveries, I also shared what I had observed that day, in addition to dusting off the old cobwebs of some algebra concepts. In my opinion, solving the math problems was not the real thrill of the day, as some of the concepts explored were still a little out of reach for many of the students. What was exciting was all the math that was grappled with in that hour-and-a-half. So many "mysteries" in the world of numbers can be pondered, explored, and possibly solved with a little perseverance. After two hours of intense brain exercise, we served lemonade and cookies as we thanked our community members for participating.

### Meeting multiple goals

In addition to accomplishing the goal of having my students work to solve our WOWs with community members who use math in their careers, I believe I accomplished two more goals. First of all, it was evident that



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Bruno's group created a negative hundred chart to prove that the multiples-of-three WOW! worked for both negative and positive numbers, but the students ran out of class time before they could fully explain all the in-depth mathematics they had explored.

my students felt empowered by working with the adults and then sharing their findings. Throughout the process, students were treated as equals and felt like they had an integral part in the potential solutions. When they shared their findings, they just glowed with ownership and displayed confidence in their group's discoveries. Only a few students were not fully invested in their mathematical results, yet they all saw themselves as mathematicians.

The second outcome of this convention had more to do with the community's perspective of our modern-day classroom. During the convention, my students effectively modeled the academic discourse that takes place all year long in my classroom. This discourse, which is vital to the integration of CCSSM, is often unfamiliar to the general public. Many adults expect a mathematics classroom to resemble those with which they were schooled. I believe it is important for our community to understand how the rigor of CCSSM and in-depth investigations must yield a different type of learning community if we are to have students who are college and career ready. For our adult participants, students' use of critical thinking, collaboration, and articulation in the final



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Adult guests observed students effectively demonstrating the type of academic dialogue that takes place throughout the year in their classroom. Here, Emma articulates her understanding of why her WOW! works for the products of numbers multiplied by nine.

presentations was an excellent prototype of what our twenty-first-century classrooms need to look like under CCSSM.

An example of such discourse was apparent in Taylor's group's discussion about her WOW. Taylor explained how the sum of the two digits for the multiples of nine always adds up to nine. Then another child in the group realized that beyond  $9 \times 10$  yields a product that does not fit the rule. At that point, Maya hypothesized that maybe the sum of the digits is a multiple of nine. For example,  $9 \times 11 = 99$ , and  $9 + 9 = 18$ , which is a multiple of nine. The adult, a university math professor, then suggested that students start a written list of combinations beyond  $9 \times 10$ . The group members continued to explore the list to make conjectures of their own, and subsequently presented their findings to the audience at the convention.

### Community connections

Having community members infiltrate my math classroom was beneficial not only for the students' growth but also for the adults' understanding of classroom practices, which are transforming to meet the needs of the

twenty-first-century learner. Holding this type of "convention" was a risk to take on my part, because I really did not know how the adults would interact with the students. I was unsure whether they would tell students why the WOW! worked or if they would help lead the students to discovering it for themselves. The STEM community proved to be a valuable resource in validating my students' mathematical thinking and empowering them to go beyond what they deemed themselves capable of. My hope is that the WOW! Convention was a seed that will lead to further community connections across grade levels in the coming school year. As Crystal Kalinec-Craig of the University of Arizona stated,

The WOW! Convention was evidence that classrooms can be safe spaces for children, families, and community members to take risks in terms of thinking about conceptually challenging ideas in mathematics.

**Common Core Connections**  
 SMP 1 SMP 2  
 SMP 3 SMP 7  
 SMP 8 4.OA.C.5

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