Environmental Math in the Classroom: What Do Your Walls Say?

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Abstract: *The authors share a template and framework to help teachers see the posters and other postings in their classrooms in new ways by thinking about Environmental Math, a type of environmental print. Who, what, where, when, and how do the walls in your classroom talk about mathematics?*

Keywords: *Teaching Aids, Algebra, Geometry, Number & Operations*

1 Introduction

The walls of our classrooms say a lot. When we look around, what does the mathematics posted in our classroom say? As two former classroom teachers with mathematics teaching experience ranging from elementary to college as well as special education (Julie and Janis) and four practicing preschool and elementary teachers (Amy, Jessica, Amanda, and Hannah), we have thought critically about the messages we post for students on our classroom walls, desks, and other spaces and offer a range of experience to help answer this question. We invited 9-year-old Isabella to contribute to this article after she contacted Julie to tell her about a problematic geometric shape poster she found in her elementary school. Her student voice reinforces how important it is that we identify potential learning concerns of the environmental math in our classrooms. We hope this article helps teachers learn how to evaluate environmental math to ensure that the artifacts that students see daily are accurate, foster rich conceptual understanding, promote student engagement, and encourage critical thinking.

What is environmental math? While still a classroom teacher, Julie was inspired by the literacy term *environmental print* (Giles & Tunks, 2010) as one way to use literacy strategies to teach mathematics. *Environmental print* consists of the symbols and signs in our everyday world: street signs, commercials, clothing labels, house numbers, books, nametags, and so forth (Harris & Hodges, 1995). Our classrooms are filled with environmental print. For example, many teachers use word walls to reinforce important words in students' environments (Giles & Tunks, 2010). Julie realized there were ways her walls spoke that were specific to mathematics. She then coined the term *environmental math* as a type of environmental print that is explicitly about mathematics (e.g., math vocabulary word walls, mathematical practices, shape posters, etc.) or that show everyday tasks that use mathematical thinking (e.g., school evacuation map, daily schedule, calendar). Although environmental math can be found outside of school, this article focuses on environmental math in our classrooms. In elementary classrooms in Ohio, if students are in the classroom for just half of each school day, they may view posted mathematical ideas for approximately 450 hours each year. In middle or high school math, students have potentially 165 hours to glance at posted artifacts. This means that the math artifacts we post may provide more reinforcement than any other resource we use (e.g., books, tasks, or other materials used during lessons). Therefore, we have become vigilant about how these artifacts might influence our students' learning.

Common question words (Who, When, Where, How, and What) are used as a framework to help us notice what our environmental math communicates. We created this framework to help us and other teachers think differently about the environmental math in our classrooms, because even experts learn more when they have frameworks to guide them (van den Heuvel & Panhuizen, 2012). In each section, we use a question word to view our environmental math artifacts with fresh perspectives. To help you get started in your classroom, we applied this framework to specific artifacts that apply to most classrooms in which students learn mathematics. Whether that classroom is elementary, middle, or high school, we must consider potential effects of environmental math on student learning. Although the adult authors of this article heavily edited each other's words, we tried not to do so with our elementary student coauthor so that you could clearly hear her voice in the words she contributed.

2 Who

Principles to Actions (NCTM, 2014) and other resources about effective mathematics instruction encourage us to consider "Who is doing the mathematical thinking in our classrooms?" Classrooms where students are invited to discover, engage, and help with decision making are usually filled with students' collaborative artifacts (Kohn, 1996; Kohn, 2010). Important questions to ask are *Who created each artifact?* and *Does the artifact encourage student interaction?* The "Who" section of the framework provides a checklist to help us think about these ideas. For example, in our classrooms, we are replacing commercially purchased problem solving steps or strategy lists with easel paper on which we record all the effective strategies our students have shared. Janis began having students post their strategies, had peers ask and answer questions about the posted strategies, and referred to the poster throughout the year. This approach helped her students try alternative strategies and grasp the content more efficiently than when she had used purchased posters. All grade levels can use this process, from kindergarten to AP calculus. Although an early elementary teacher may write these posters to ensure readability and accessibility, we still consider these student-created artifacts because the teacher summarizes her students' ideas.

Examples of commercially created artifacts that encourage interaction include a hanging number line (not taped to the wall), so students can use clothes pins to represent their thinking. Instead of buying geometric shape posters, encourage students to create their own accurate posters which might look like Figures 1 and 2.

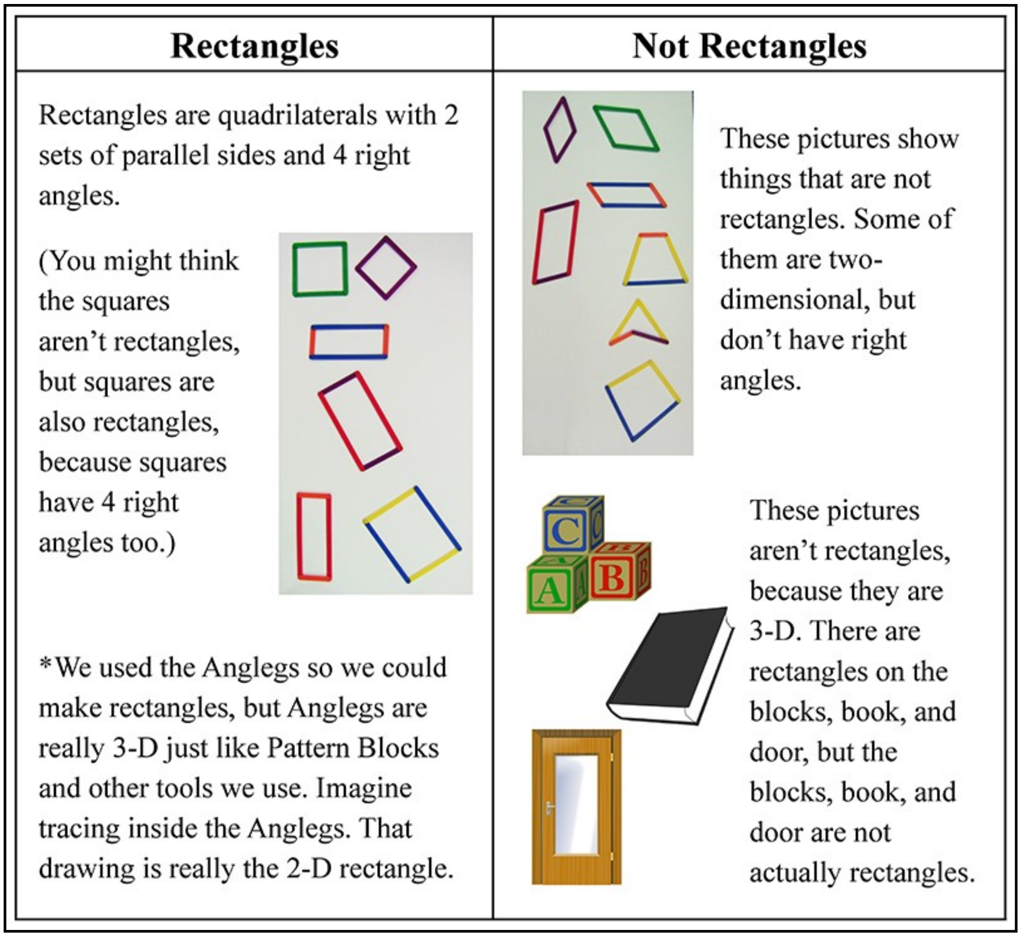

Fig. 1: *Elementary poster distinguishing rectangles from non-rectangles.*

Another important question to ask is: *Who sees their work on our walls and views themselves as mathematically capable?* Teachers must counteract biases that say only some are capable of doing mathematics and help all students see themselves and others as capable of having a mathematical mindset (Boaler, 2016; Felton, 2010). Using the example of student strategy posters described above, *Whose strategies are posted?* Students who struggle with math must also have opportunities to share their strategies and see themselves as mathematically competent. The "Who" checklist can help teachers think about ways to enhance how equitable the class environment is.

3 When

Just as it is an important literacy strategy to introduce a book before making it available to students (Layne, 2015), we should apply these same principles to posting environmental math. The "When" section of the template helps us think about when to introduce artifacts. Discussing artifacts with our students can help us understand how students interpret these ideas so we can remove or modify artifacts to enhance student learning. For example, the strategy posters of student ideas described in the "Who" section are created during instructional units and referred to throughout the year. On the "When" portion of the template, we would check "Discussed or created artifact before posting" and also "Discussed artifact when relevant to a lesson-frequently."

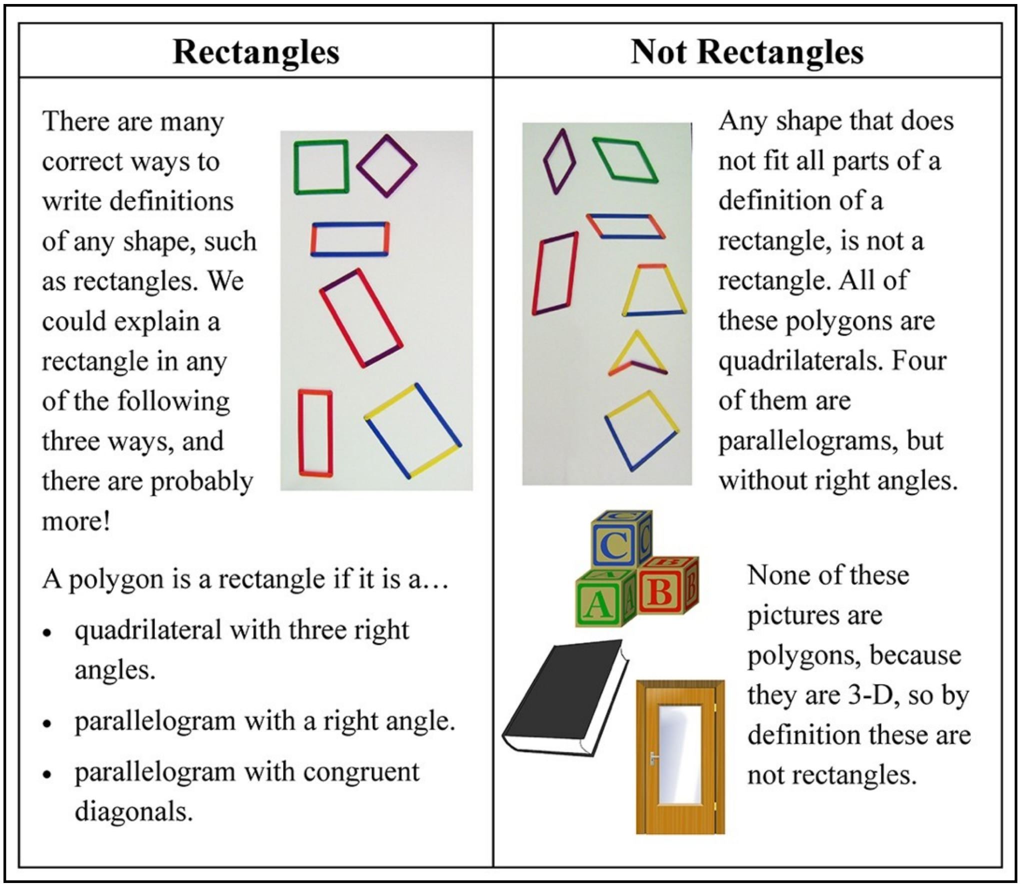

Fig. 2: *Secondary poster distinguishing rectangles from non-rectangles.*

4 Where

Artifacts need to be visible and accessible to students wherever they may be working. Posting a number line high on our classroom walls, for example, makes it visible to most. However, this position prevents students from using it as a mathematical tool. Instead, Amy posted her number line below the board so it is accessible to her elementary students as a resource for thinking. This placement allows students to move along it using clips to track their processes, which also helps them physically experience the relative magnitude of different numbers. This placement would, however, be too low for adolescents. Middle grade or high school students, for example, might use the walk-it-off number line model (Nurnberger-Haag, 2007) to understand why the product of two negatives can be positive and why subtracting a negative number yields a larger number. These students would need a number line posted at hip height with sufficient spacing to step from integer to integer. On the "Where" part of the template, Amy would check off "students' eye level when sitting on the floor" and "students can interact with artifact during most mathematics work times." Whereas in Julie's secondary classroom, students used the walk-it-off model posted at hip height, so she would check off "students' eye level when sitting at a desk."

5 How

How do my walls show people doing mathematics? Do they promote a *mathematical mindset* (Boaler, 2016)? Resources such as levels of cognitive demand promoted in *Principles to Actions* (NCTM, 2014) and the *Mathematical Practice Standards* help us think about how our walls show students' thinking.

5.1 Mathematical Processes

The framework encourages us to determine if artifacts that are not specifically about mathematical practices are consistent with these practices. We can help students understand the complexity of problem solving by removing posters with prescribed steps, which may be misleading, and instead replace them with posters that students create to show their own processes. Students should value their own and others' processes instead of referring to posters for a single correct process.

When our walls encourage students to recognize their own mathematical competence and to persevere in solving problems (MP1), they show students that we value mathematics. Julie posted motivational environmental print about mathematics to empower students. Among other approaches, she decorated her door to say "Math Opens Doors to Your Future." Moreover, she made the NCTM "Do Math" bear a class mascot. Students took turns setting the bear on their desk to look over them while working. The bear was so important to one high school student who typically struggled that he built a chair for it (Figure 3).

Fig. 3: *The NCTM "Do Math" bear mascot sitting on the chair a student made for it out of leather and wood.*

5.2 Cognitive Demand

One resource that helps us plan tasks and pay attention to our students' thinking during lessons is the Cognitive Demand framework, which separates lower (*Memorization* and *Procedures without Connections*) and higher (*Procedures with Connections* and *Doing Mathematics*) (Smith & Stein, 1998) cognitive demand tasks. Because these resources helped us to understand that we should balance instruction across demand levels (NCTM, 2014; Stein & Smith, 2011), we realized our environmental artifacts should also be balanced. This means that at most, only some posters should be at the Memorization (e.g., typical geometric shape poster) or Procedures without Connections (e.g., a list of steps to do long division) levels.

The strategy posters discussed in the "Who" section could exemplify Procedures with Connections. An artifact that can encourage Doing Mathematics is a place where students post conjectures, which could be named an "I Wonder Wall." This wonder wall should not be a parking lot where ideas languish. Instead, we must make time so that our students can explore these conjectures at a Doing Mathematics level. In all ages of classrooms from kindergarten through twelfth grade, it can be helpful to plan a recurring lesson at regular intervals (e.g., quarterly, monthly, or possibly even weekly) in which students work in groups to investigate a subset of the conjectures.

6 What

What mathematical domains and topics are posted on our walls? Answering this question may be done quickly. However, next we need to ask ourselves the most important question: *What benefits and issues are there with the way these mathematical topics are portrayed?* To answer this question, we need to think about the mathematics itself and learning objectives as well as nuances of how students think and learn. To ensure we see the environmental math with a fresh perspective, we benefit from using reputable sources that point out the varied ways students think about a topic. To provide foundations for later learning we must also use resources that include ideas below and above the grade levels we teach.

We must also look for potential misconceptions our walls could communicate to students. The article "13 Rules that Expire" (Karp et al., 2014), for example, explains how short-cut rules or generalizations often "expire" because they may work for certain standards that involve whole numbers but expire when students learn integers or rational numbers (e.g., saying you can't take a larger number from a smaller number), which causes student difficulties later. A useful guide to identify problems with environmental math is to ask ourselves, *How do the artifacts limit students or teach ideas that expire?* We first offer several examples from elementary and secondary classrooms that will help you think about the "WHAT" portion of the environmental math. Then at the end of this section we explain more generally what questions to ask about any mathematics found in our classroom artifacts.

6.1 Equals Sign

In elementary and middle grade classrooms, if the artifacts on our walls show an equals sign, we should promote a relational meaning of the equals sign and avoid limiting student conceptions by saying that the equals sign means "total" (Falkner, et al., 1999). A statement such as "equals means is the same [value, number, length, width, etc.] as," is crucial to promote the relational meaning of the equals sign instead of an operational meaning (Falkner et al., 1999). The majority of equations should show equals signs in non-traditional positions (e.g., $12 = 12$,$\frac{3}{4} = \frac{9}{12}$, $12 = 25 - 13$, $3 + 5 = 4 + 4$ or $18 - 5 = 6 + 7$; $14 = (-2)(-7)$, including equations with variables for upper grades (see also Falkner et al., 1999).

6.2 Base-Ten Number Operations

Karp and colleagues (2014) encourage teachers to identify additional rules that expire. We realized place value charts limited to three places are one such rule commonly found, yet this expires by third grade. Regardless of our intentions, a chart that shows only hundreds, tens, and ones, prompts students to think there are only three place values. As a result, we have heard students in many classrooms say the reason they know a number is in the hundreds place is because it is the "first one." However, this thinking about place values can make it more difficult for students to use larger place values and decimals. To better support student learning of base-ten numbers long-term, posters should extend several place values in both directions beyond the grade level standard and indicate these continue forever.

6.3 Number Systems

Teaching number system terms helps middle and high school students understand how what they are learning fits into larger patterns of mathematics. Although it is usually in Algebra II when high school students first encounter imaginary numbers, Julie introduced her middle school students to number systems by constructing Venn diagram displays with her students to show all number systems: natural numbers (counting numbers), whole numbers, integers, rational numbers, real numbers and imaginary numbers and then referred to these displays during lessons to show where the current learning objectives fit into these number systems.

6.4 Number Lines

After seeing number lines on numerous elementary classroom walls and student desks, we realized that excluding 0 and negative numbers limits students' thinking. Although many teachers worry they will confuse children by posting ideas beyond grade level expectations, when Julie had children as young as three and four build number tracks on the floor (with one numeral per card) from 1 to 8 and then gave them a 0 card, many children could correctly place the numeral 0 before 1. In fact, the next day the mother of one child told Julie that her 4-year-old daughter was so proud that she knew where 0 went that "she talked about it all afternoon." As early as kindergarten, if number tracks or number lines are used, they should include numbers before one and beyond the current grade-level standard. Such environmental math can spark curiosity and lead to student-initiated ideas and questions. For example, for her second-grade classroom Janis sought desk name tags with negative numbers as well as positive numbers greater than 20. Making this simple change for the number lines in the students' environment going from -20 to 100 helped these second-grade students recognize 0 as a valid number and even prompted some students to challenge themselves to use negative numbers to solve the assigned whole number problems.

6.5 Geometric Shapes

Even adults who have passed high school geometry tend to think of shapes in prototypical ways. For instance, many are shocked to discover that every square is a rectangle and that trapezoids needn't resemble those found in children's books (Nurnberger-Haag, 2017; Fujita, 2012). Thus, a common need across elementary, middle school and high school is to work to break a cycle of misinformation that begins in infancy (Nurnberger-Haag, 2017; 2018). Isabella (9-year-old coauthor) found an inaccurate poster in her school's PreK-K wing. As Oberdorff and Taylor Cox (1999) argue, Isabella wants to ensure that resources teach children correctly from the beginning. When kindergarteners and preschoolers continually see the same poster with wrong shapes on it, they will think these are correct. As an example like the one Isabella found in her school, when they see a globe called a circle and a tent called a triangle on the poster, they will accept that knowledge as correct. Circles and triangles are two-dimensional, but globes and tents are three-dimensional.

Even if a mathematical artifact is technically accurate, it may promote limited conceptions. The old adage "a picture is worth a thousand words" reminds us regardless of how complete and accurate a written definition is, the pictures that serve as examples of shapes could potentially influence students concepts more than the definitions. To help us critique geometric shapes posted in our classroom, we find it helpful to start with this publicly available rating system designed to analyze the shapes in children's story books (Nurnberger-Haag, 2018). The rating system (Nurnberger-Haag, 2018) helped us notice that commercially produced posters for secondary and elementary classrooms typically portray rigid and inaccurate prototypes of geometric shapes. Moreover, the rating system revealed that two types of elementary products can be especially problematic: desk name tags and commercial calendar math sets. These nametags, posters, and other resources inaccurately imply that a "trapezoid" must be isosceles (two sides the same length) and incorrectly teach that every four-sided shape is mutually exclusive from another (i.e., rhombuses are not parallelograms, and squares are not rectangles). We have seen students create accurate varied models of triangles on geoboards, but then doubt themselves because the shapes did not look like the "typical" triangles on their class calendar. In contrast, in an elementary classroom where the calendar emphasized irregular polygons (e.g., hexagons with unequal sides), these prompted discussions about mathematical properties that benefited students' shape learning. Other resources such as articles in the geometry special issue of *Teaching Children Mathematics* (February 1999) may help teachers of all grade levels recognize benefits, limitations, and inaccuracies in teaching resources.

6.6 Measurement

Although the standards for estimating length, liquid, or mass measures end by third grade and understanding relative sizes of standard measurements by fifth grade, those of us who have taught middle school, high school, and adults know that this is a topic that people of all ages still misunderstand. In her secondary mathematics classes, Julie found that regardless of whether students were taking her life skills mathematics course or a course like Algebra II, all of the students benefited from visuals and hands-on experiences measuring lengths, liquids, and mass. An environmental artifact that provides these opportunities is an Estimation Station with a different activity each week. Measuring cups, weights, and strips of card stock cut to the length of each standard unit length measurement work as references for whatever lengths, volume, or mass we use in the Estimation Station each week. Having all of the same tools available all the time also provides the rare opportunity to expect students to appropriately choose tools for the attribute being measured, which is the point of MP5.

6.7 General "What" Questions to Ask Ourselves

We chose each of the earlier specific examples because they are common to multiple grade levels in the hopes that this could help you see the benefits and potential issues of artifacts that might be posted in your own room. More importantly, we hope these examples make it easier to use the template to expand beyond these specific examples to notice benefits and issues of other mathematical ideas posted on classroom walls. Some readers of this article may have advanced degrees in mathematics or decades of mathematics teaching experience, whereas other readers are responsible for knowing many subjects to teach elementary students. Regardless of how well we believe we understand the mathematics we teach, we find it helpful to always assume we have more to learn. By looking at our artifacts with a more critical eye, we can avoid creating misconceptions and help foster richer mathematical thinking. To critique our artifacts for these issues, we refer to articles and other resources as we ask ourselves some what questions about our environmental math (see Table 1):

- What mathematics did we want our students to learn by posting this artifact?
- What could we add? What might be missing?
- What should be changed?
- What words are used? Are these artifacts written in language my students would understand?
- What, if any, inaccurate information is posted? Are these rules that expire and are only true in certain cases?
- What is posted that might implicitly lead students to have misconceptions about this topic?
- What are some reputable resources that will help me more deeply understand the mathematical topic and/or how students learn and think about this topic?

If you are wondering what other potential misconceptions could be lurking in environmental math artifacts, we invite you to check the resources in Table 1 to add to your library of reputable information. Some of these are older but highly beneficial, such as the 1999 special issue on geometry in *Teaching Children Mathematics*. A special issue on misconceptions that will appear in *Mathematics Teacher* in 2019 should be another important resource to add to our libraries.

Table 1: *References that could help identify benefits and issues with mathematics content of artifacts.*

Resources	Number & Operations	Algebraic Thinking	Number Systems	Expressions, Eqns & Ineqs	Functions	Geometry	Measurement & Data	Probability & Statistics
Casa, T., Spinelli, A., & Gavin, M. (2006). This about covers it! Strategies for finding area. *Teaching Children Mathematics 13*(**3**), 168–173.							×	
Dietiker, L., Gonulates, F., & Smith, J. (2011). Understanding linear measure. *Teaching Children Mathematics 18*(**4**), 252–259.							×	
Falkner, K., Levi, L. & Carpenter, T. (1999). Children's understanding of equality: A foundation for algebra. *Teaching Children Mathematics 6*(**4**), 232–236.	×	×		×	×			
Karp, K., Bush, S. & Dougherty, B. (2015). 12 math rules that expire in the middle grades. *Mathematics Teaching in the Middle School 21*(**4**), 208–215.	×	×	×	×				
Karp, K., Bush, S. & Dougherty, B. (2014). "13 rules that expire." *Teaching Children Mathematics 21*(**1**): 18–25.	×	×	×	×			×	
Nurnberger-Haag, J. (Fall 2018). Follow the signs to promote accurate geometric shape knowledge: Together we can break the cycle of misinformation. *Ohio Journal of School Mathematics 80*. Retrieved from `https://library.osu.edu/ojs/index.php/OJSM/article/view/6041`						×		
Nurnberger-Haag, J. (2016). Mathematics Education Podcast 1609 `https://www.podomatic.com/podcasts/mathed/episodes/2016-11-23T06_26_27-08_00`						×		
Nurnberger-Haag, J. (2007). Integers made easy: Just walk it off! *Mathematics Teaching in the Middle School 13*(**2**), 118–121.						×		
Powell, S. & Nurnberger-Haag, J. (2015). Mathematics Education Podcast 1519 `https://www.podomatic.com/podcasts/mathed/episodes/2015-05-04T06_48_40-07_00`	×							
Roberts, S. (2007). Watch what you say. *Teaching Children Mathematics 14*(**5**): 296–301.						×		
Special Issue on Geometry, *Teaching Children Mathematics* (Feb, 1999)						×		
Special Issue on Misconceptions, *Mathematics Teacher* (TBA, 2019)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Wolbert, R. & Moss, E. (2018). Developing the concept of a radian. *Mathematics Teacher 11*(**4**), 272–278.						×	×	

7 Take Action

We invite you to use the template in the Appendix to analyze number lines in your classroom and compare them to Figure 4. This figure describes how we used each question word of the framework to evaluate posted number lines. Moreover, we hope to inspire you and your students to analyze other artifacts of environmental math in similar ways, one artifact at a time.

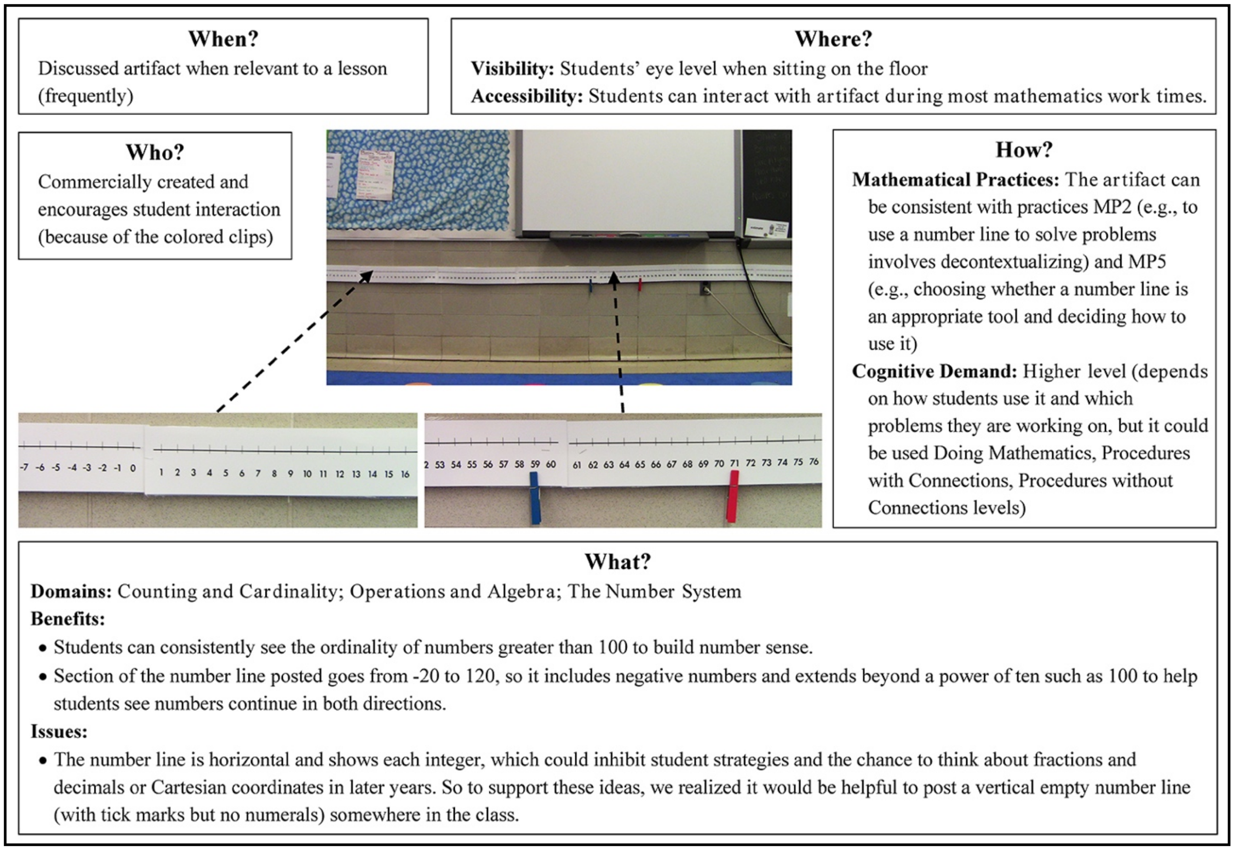

Fig. 4: *An example of how to use the framework to analyze an artifact of environmental math.*

7.1 Advice for Future Teachers and Instructors of Teacher Preparation Courses

Jessica, Amanda, and Hannah are now classroom teachers who originally thought about these ideas during a methods course taught by Julie. They encourage other instructors of methods courses to give preservice teachers the chance to critique environmental math as they did. Having just designed their classroom spaces as first-year teachers, these authors advise future teachers that learning to analyze environmental math will prepare you to set up your own classroom for optimal learning. One idea is to take pictures of mathematical artifacts in your field placement classrooms and use the template to critique these with your colleagues. Whereas we suggest methods instructors use the entire framework, instructors of mathematics content courses might use just the "what" portion of the template that focuses on the mathematical content as a way to develop future teachers' content knowledge.

7.2 In-Service Teachers

For readers who currently have their own classrooms, it is helpful to evaluate environmental math with a partner who teaches a different grade and is unfamiliar with your room. When colleagues from different grades talk about how mathematical ideas build across grades, it helps us notice implicit misconceptions that artifacts might communicate to students. Using the framework with a partner to look for mathematics on our walls can also help us see the potential for mathematics in unexpected places. For example, all of us have school maps posted in our classrooms for the purpose of student safety, but the framework helped us realize the potential to help students of various grade levels to recognize the mathematics in real-world artifacts. We can use these school maps for geometry, measurement, proportions, scale, and so forth. Even our class reward systems can serve a dual purpose to promote mathematical thinking. Amy placed a magnet on her board for each point that students earned in her elementary class reward system (See Figure 5a). Doing so motivated her students to structure quantities by fives and tens as they worked to determine how many more points they needed for a reward (See Figure 5b). This representation promoted students to use greater number sense than if her reward system had simply been to fill a physical glass jar with marbles. A middle school or high school reward system might use representations of negative numbers in similar ways, such as with two colors of magnets similar to a manipulative chip model.

Fig. 5: *Example of how postings such as class reward systems can be created or tweaked to foster students' mathematical thinking.*

8 Final Thoughts

This article encourages educators to carefully consider every artifact we put up in our classrooms. Many of the artifacts we hang in our classrooms to help our students, may not produce the intended results. An artifact may tempt students to memorize a rule instead of encouraging them to discover a new mathematical idea or process. Some artifacts are even inaccurate, so we must be vigilant before we spend our limited personal funds to buy commercially prepared resources. Our coauthor, Isabella, who was 9 at the time we first wrote this article urges teachers to make sure everything in our class is accurate. She advises that just having one thing wrong on a poster can still make an impact. Something small may become something bigger. A high school geometry teacher who posted a consumer review of a childrens shape-related book reinforced Isabella's plea that inaccuracies have long-term implications: "I'm sick to death of trying to beat these misconceptions out of the heads of my high school geometry students. Avoid putting them into your child's head in the first place" (Hemminger, 2013). We hope you find the framework and the template in the Appendix helpful for revealing which items to remove and how to tweak others to provide better learning opportunities. Now it's time to print the template, find a partner and ask: "What do my walls say?"

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Amy Hopkins has been a second-grade teacher at Kent City Schools in Kent, Ohio for 13 years. Recently, she has shared her love of teaching and learning with future teachers as an adjunct professor at Kent State University.

Jessica Ries is a graduate of Kent State University and is currently an infant teacher at the Jewish Community Center in Akron, with aspirations to move to the South within the next few years and become a lower elementary teacher. She has a lifelong love for learning, which she intends to share with children and adults of all ages.

Amanda Catterall is a graduate of Kent State University and is currently a third-grade teacher at Collier Elementary in Avondale, Arizona. She is excited to continue learning and growing alongside of her students.

Hannah Strozyk (Maxwell) is a graduate of Kent State University and is a first-grade teacher at Our Lady of the Lake School in Euclid, Ohio. She is excited to share a love of learning with students and teachers everywhere.

Isabella J. Branham at the time of publication is a fifth-grader at Brick Elementary School in Ypsilanti, MI. She loves art and science and for a career plans to do something in the sciences such as become an architect, engineer or zoologist.

WHO

Who is part of the Environmental Math?

Who created the artifacts? (check all that apply)

- ☐ Students created
- ☐ Teacher created and once posted, encourages student interaction
- ☐ Commercially created and once posted, encourages student interaction
- ☐ Teacher created, but once posted, student interaction unlikely
- ☐ Commercially created, but once posted, student interaction unlikely

Whom does the artifact show doing mathematics?

Whose work is displayed? How well does the diversity of gender, race, languages, achievement levels and so forth reflect our class community? ____________________
____
____

If there are images of people, such as from commercially created posters, do these reflect the diversity of gender, race, and languages in our world, so that students see themselves as well as others different from themselves as doers of mathematics?_______________
____
____

WHERE

Where is the environmental math?

Visibility (check one)

- ☐ More than 3ft higher than typical student eye level
- ☐ Students' eye level when standing
- ☐ Students' eye level when sitting at desk
- ☐ Students' eye level when sitting on the floor

Accessibility (check one)

- ☐ Students can interact with artifact during most mathematics work times
- ☐ Only when in certain location (where?) ____________________________________
- ☐ Students cannot reach it or students not allowed in that space (e.g., behind teacher's desk)

WHEN

When do we talk about the artifact of environmental math?

(Check all that apply.)

- ☐ Discussed or created artifact before posting
- ☐ Discussed artifact when relevant to a lesson
  - o 1-2 times
  - o Sometimes
  - o Frequently____
- ☐ Never discussed artifact
- ☐ Other ____

HOW

How does the artifact portray mathematics?

How does the artifact portray how people do mathematics?

What are practices and processes of mathematics?

Mathematical Practices (check all that apply)

- ☐ The artifact shows Mathematical Practices posted in student-friendly words
- ☐ The artifact explicitly motivates and values mathematics
- ☐ This artifact is not explicitly about the practices or motivation. How consistent is this environmental math artifact with the practices?
  - o Consistent with practices (Which practices?) ________________________
    ____
  - o Contradicts practices (Which practices?) ____________________________
    ____

Cognitive Demand (check all that apply)

Higher Level

- ☐ Doing Mathematics
- ☐ Procedures with Connections

Lower Level

- ☐ Procedures without Connections
- ☐ Memorization

WHAT

- *What* mathematics did we want our students to learn by posting this artifact?

- *What* could we add? *What* might be missing?

- *What* should be changed?

- *What* words are used? Are these artifacts written in language my students would understand?

- *What*, if any, inaccurate information is posted? Are these rules that expire and are only true in certain cases?

- *What* is posted that might implicitly lead students to have misconceptions about this topic?

- *What* are some reputable resources that will help me more deeply understand the mathematical topic and/or how students learn and think about this topic?

- *What* more did I realize about what this artifact might teach students after checking these resources?