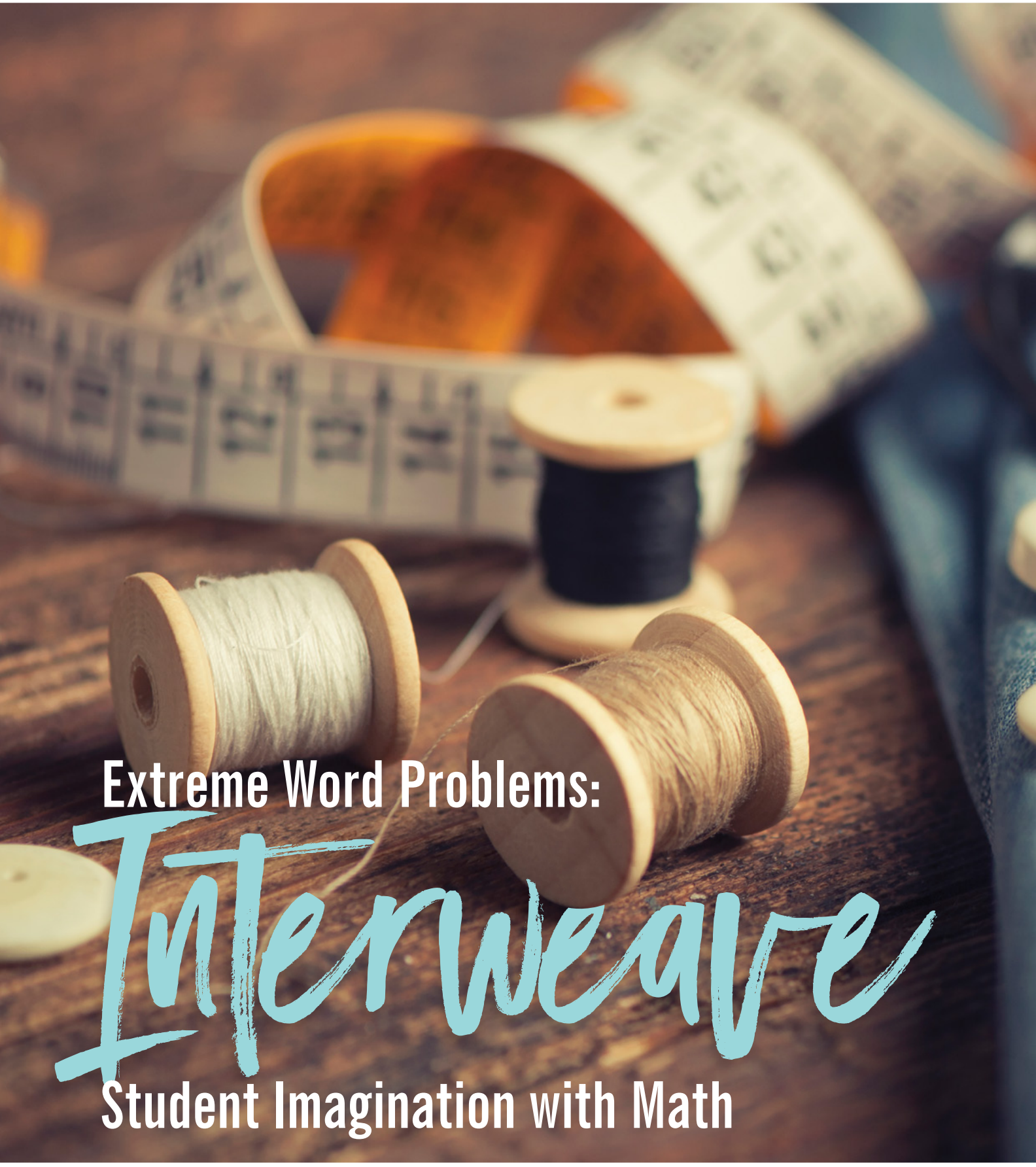


Extreme Word Problems: Interweave Student Imagination with Math

Let students find the connecting thread to create, illustrate, and share word problems to bridge school math and real-life math.

Angela Marie Frabasilio

Three vampires were walking down the street when they ran into, you guessed it, a linear equation. Ever try to captivate students with real-world applications only to discover that they live in a very different world? Assigning an Extreme Word Problem activity to students alleviates this dilemma by placing the authorship of a problem squarely into the hands of learners. Rather than trying to be hip and finding word problems that resonate with your students, allow them to produce the problems. In so doing, you will get a glimpse of their thinking as they create and frame their own problems in meaningful contexts. You will also become better acquainted with your students as they interweave their interests into mathematics.

Students rarely see how a problem is written, which is a key element in finding a solution (Brown and Walter 2005). Einstein and others recognized that the "formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical skill or experimental skill" (Einstein and Infeld 1938, p. 92). With extreme word problems, students create a scenario that tells a wacky, mysterious, or eccentric story using 250 or more words. Although the story may be as extreme as the student chooses, it must generate a mathematical problem. This activity of writing problems, designed for

seventh graders, can be adapted to various grade levels.

If technology is available, students can use a computer or electronic device that supports Google Slides™ or other similar applications and will need a connection to the Internet. The teacher will need to prepare a Google Slides presentation in advance and show the assignment and the grading rubric.

Technology can also be extended by using other media, such as animation, video, RSA animate, or infographics. Students could publish their presentations to share within a community. For a no-tech option, students can produce a one-page drawing or cartoon depicting a scene from the story. The equation and short word problem are embedded in the artwork, with the extreme story written on the backside of the artwork.

Student Skills Relevant to Extreme Word Problem

The first time I taught this lesson, I noticed a gap in student learning. My students could solve two-step equations, but they could not create them. In addition, some could not make the leap from the storyline to the mathematical representation. The following game and problem aided student comprehension.

GAME: COMPOSE AND DECOMPOSE EQUATIONS

Ask students to create two-step equations forward and backward using individual whiteboards. One student will create the equation, and the other student will solve it.

An example of creating a two-step equation:

$$x = 5$$
$$4x = 20$$
$$4x + 6 = 26$$

An example of solving a two-step equation:

$$4x + 6 = 26$$
$$4x = 20$$
$$x = 5$$

PROBLEM: CONVERTING MATHEMATICAL SYMBOLS TO STORY

Ask students to create a simple word problem that represents a given situation.

Going Bowling	Create a Word Problem That Uses the Information on the Left	Solve the Word Problem by Solving the Equation
\$4 per game \$6 shoe rental x = games Abbie's spending $4x + 6 = \$26$	Abbie has \$26. If the cost of renting bowling shoes is \$6 and the cost per game is \$4, how many games can she play?	$4x + 6 = 26$ $4x = 20$ $x = 5$ Five games

Day 1: Introduction

The teacher places a warm-up problem on the board:

> Write an equation that you would use to solve the following problem and solve it: Allie gets paid \$21 a day plus \$2 per pair of jeans she sews. How many pairs of pants does she have to sew today to earn \$33?

After students completed the warm-up, the teacher asked, "Well, how did you like that problem?" Students, a bit confused, started discussing possible solutions. The teacher interrupted, "I didn't ask you about your solutions. I asked how you liked it. What did you think of it?" She quieted the class and read the first slide of the presentation (see **fig. 1**).

The teacher continued:

> How long had she been working in the factory? She couldn't remember. But that didn't matter. Tonight was the night it would all come together. She was going to meet her. The girl who would change her family's life forever, the one they had thought was long dead. . . .

The teacher wove her students' attention further into the journey, ending abruptly with this statement:

> Allie urged herself to refocus on her work. Thirty-three dollars was needed. How many more jeans before she could change out and collect her pay?

A student voiced the class's unhappiness with the ending by saying, "Wait, what's the end of the story?" The teacher replied, "I don't

IMAGE ON PREVIOUS PAGE BY FABIOBALBI, ISTOCK / GETTY IMAGES PLUS

know, but how did you like *this* problem?" A class discussion ensued about the differences between the warm-up problem and the extreme word problem. Then, the teacher said, "Now it's your turn to make a problem to share."

Students were given this assignment:

1. Create a longer and more detailed, extreme story (see **fig. 2**).
2. Write a simplified version of the extreme story using two or three sentences, similar to a warm-up or textbook word problem (see **fig. 3**).
3. Produce a representative two-step linear equation.

In class, students began by creating a draft. The teacher asks students to divide their papers into fourths on both sides of the sheet and sketch thumbnails of their story. The thumbnails included a title, the extreme story, a simplified version, and a mathematical equation. Quiet time was allocated for individual thought, then students shared their story ideas with partners. The class used the remainder of time to confer, edit, and refine their story to match the rubric's requirements (see **fig. 4**). The teacher worked with individual students to differentiate learning. (See **fig. 5** for accelerated learner ideas and intervention story starters.)

For example, seventh-grader, Maya, formulated this problem:

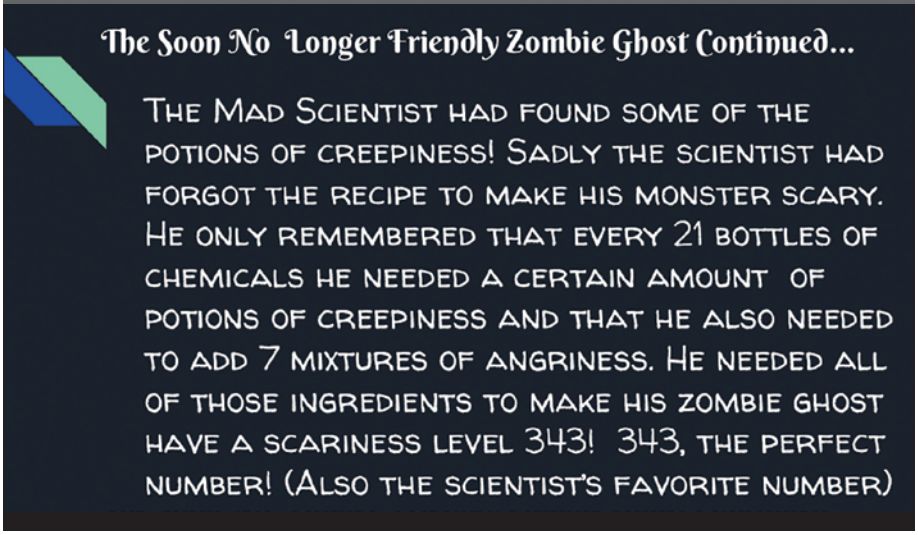
> Agatha the witch is planning to throw a party. She wants to make a potion that will help her look pretty. She has $460 to spend at the market. While she was at the market, she got a skunk's tail, which cost her $250. She also found eyeballs for $7 each. With her budget of $460, how many eyeballs can she buy? $460 = $250 + $7*x*.

Fig. 1 The teacher presented this first slide of her extreme word problem to the class.

Allie's eyes followed the seam of the jeans. The stitches clicking between her thumb and forefinger. The fabric pushed gently against her palm. It was difficult for her to concentrate as she peeled the jeans off the machine and tossed them into the second stage bin. **Twenty one dollars for the day and two dollars for every pair of sewed jeans.**

KHEEL CENTER, CORNELL UNIVERSITY, AT CATHERWOOD.LIBRARY.CORNELL.EDU/KHEEL

Fig. 2 This example illustrated one slide of a longer, more detailed word problem.



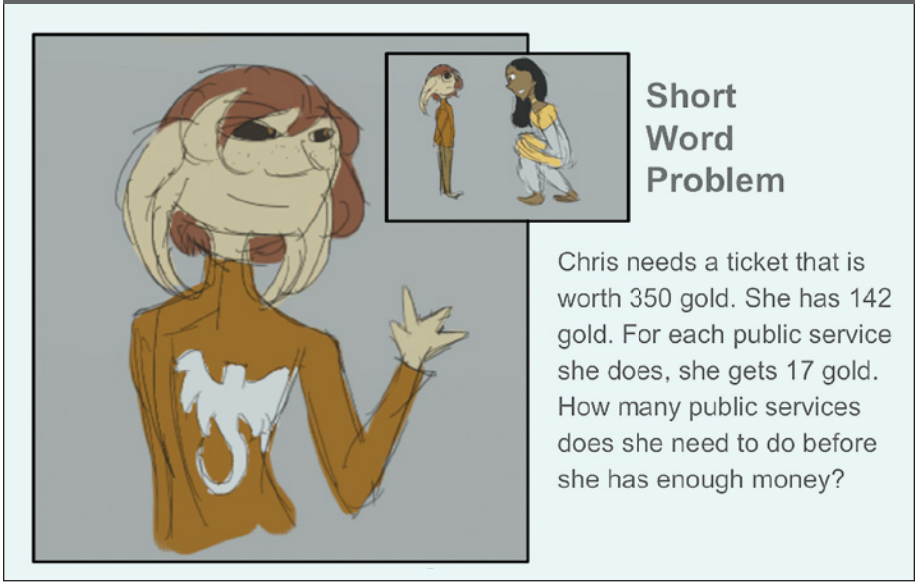
She sketched drafts of her ideas, imagined a shortened textbook version, created simple thumbnail drawings with storyline ideas, and added an equation. She talked with her teacher and peers to make sure her equation matched her imaginary situation.

Within this process of talking with peers, students were communicating about mathematics, recognizing problem entry points, making sense of the problem, and modeling math. The problem crossed into the language arts realm as students were planning, brainstorming, and drafting an outline.

Day 2: Project Building

Students transferred their ideas to Google Slides. They embellished their stories, added images, and shared editing rights with their teacher. The teacher reminded them not to embed answers into their word problem and instructed them to place the equation on the final slide. At this time, Maya collected images of witches, skunks,

Fig. 3 This simplified version was to resemble a textbook word problem.



and eyeballs from the Internet and extended her writing to meet the 250-word requirement.

Once students completed this stage of the process, they have gained experience with producing Google slides, naming their files, inserting photographs, sharing settings, learning about citing images, and using free public domain and licensed images. Their graphic-design skills increased by learning about photograph resolution, pixilation, image stretching, font size, color, style, and layout. They also used such language art skills as writing and paying attention to sentence structure, spelling, punctuation, and voice.

Students come to us like varying stages of unfinished patchwork quilts. In our year with them, we quickly try to assess cohesiveness and stitch between patches of their knowledge.

Day 3: Project Sharing

After project building, students paired with another, shared information, and gave feedback. The teacher demonstrated peer sharing. She selected a student's project and projected it on the whiteboard. She read through the story, stopping short of the final slide that contained the equation. She filled out questions 1 and 2 of the helper rubric (see **fig. 4**). As she wrote down what she liked and what was done well, she referenced the rubric. Emphasizing the importance of question 2, she analyzed the story's mathematical information and predicted the equation. She checked her prediction against the equation on the final slide.

"You are now going to help your partner by giving him or her feedback. Open your story and share viewing rights. Silently read your partner's story, then fill out box 1 and 2 of the rubric. When you are finished, hand the helper rubric back to your partner and discuss what you have written. Remember to be kind and use 'I' statements in your writing as well as your conversations."

Students were excited. Maya challenged her partner to guess the linear equation represented in her story. Another student helped his partner rewrite an equation to match the story scenario properly. Accountable talk, demonstrated in peer sharing, guides deep learning and promotes literacy in mathematics (Hattie et al. 2016). Following the sharing, some students made final changes to their project. They self-graded by circling corresponding boxes in the rubric (see **fig. 4**).

LEARNING THROUGH EXTREME PROBLEM CREATION

Students come to us like varying stages of unfinished patchwork quilts. In our brief year with them, we quickly try to assess cohesiveness and stitch between patches of their knowledge. We pull their learning into a more connected whole. My students struggled to connect with and understand textbook word problems. After trying to create engaging problems, I found it easier to have students create their own. The Extreme Word Problem activity was born. To make it fun, problems became extreme. I added the shortened "textbook" version with the hope that students would empathize with textbook authors. Following the activity, when students seem uninspired with a textbook problem, we imagined it in an extreme version, rich in detail. And then we solved it.

This lesson tugs on many threads. Most important, students freely create mathematics from their own fabric, their questions, their knowledge. These types of problem-posing

Fig. 4 A rubric structured what peer helpers were to "grade."

Helper Rubric for the Extreme Word Problem Activity

Extreme word problem title:

Helper name:

1. What did you like? What was done well?

2. How does the mathematical equation match the story? Was there anything that was confusing?

3. Author name:

Element	1	2	3	4
Slide presentation	Slide presentation does not have multiple slides or 0 images or no title page.	Slide presentation has multiple slides, 1–2 images. May not include title page.	Slide presentation has multiple slides, 3–4 images and a title page.	Slide presentation has multiple slides, at least 5 images, and a title page.
Graphic design	Slide composition is difficult to understand. Fonts are confusing or difficult to read.	Slide composition is complete but not compelling, fonts are consistent and readable.	Slide composition is enjoyable to look at, fonts are well selected and easy to read.	Slide composition is stunning, fonts are well selected, consistent, and easy to read.
Equation	Equation is a one-step equation, partially correct or does not match the storyline.	Equation is a one-step equation written correctly and matches the storyline.	Two-step equation is partially correct or does not match the storyline.	Two-step equation is correctly written and matches the storyline.
Condensed textbook problem		Partially simplified textbook problem, or it does not relate to the extreme problem.		Textbook problem is condensed and correctly relates to the extreme word problem.
Extreme word story	Extreme story is less compelling, or lacks appropriate composition and punctuation. Less than 100 words, No citations included.	Extreme story is less compelling, or lacks appropriate composition and punctuation. Less than 250 words. Citations included.	Extreme story is compelling, with appropriate composition and punctuation. 250 words. No citations included.	Extreme story is compelling, with appropriate composition and punctuation. 250 words or more. Citations included.

Fig. 5 To both differentiate instruction and provide help, an accelerated version (a) and a story starter (b) can be used.

Accelerated version: Challenge students to create complex problems, such as three-step or four-step linear equations, quadratic equations, and so on.

(a)

Story starter: Provide ELL and struggling students with fill-in-the-blank sentence starters. Example:

One day, _____[name] decided to go to _____[place]. He/she was so excited! It was going to be a lot of fun. It cost $_____ to get into the _____[place], and $_____ for every _____ [thing/ride]. He/she only had $_____. How many _____ [things/rides] could he/she buy?

(b)

activities help students develop more creative approaches to finding solutions (Silver 1997). Students assume ownership within the license to create. The combination of technology use and sharing with peers fosters an atmosphere of play, which lends itself to inventiveness (Bateson and Martin 2013). The extreme portion of this lesson frees students of seriousness, inviting them to create something unusual. It allows them to be silly, mysterious, scary. The seemingly backward nature of problem formation removes some of the expectations and stresses that students may feel in mathematics classes (Arikan and Unal 2014). Students see problems in a different way. Those strong in storytelling gain a foothold. Students who love technology confidently use the tools. Students overly eager to follow a pattern or use a formula are forced to think outside the box.

PROBLEM CREATION: AN EFFECTIVE CURRICULUM TOOL

My seventh graders gained insight into how to use mathematics as a tool and weave their extreme situations into mathematics. My students reflected on the activity, which resonated with the Common Core standard of reasoning abstractly and quantitatively (CCSSI 2010), and agreed on the struggles involved. One student commented, "It gave me a different perspective on how to solve questions. It also made it so that I had to look hard for the information instead of just having it right in front of me."

Another simply said, "It made me think harder." Many students said that creating word problems was difficult but that once they understood the process, they felt empowered to create word problems involving aspects of their lives: "It made me see that we do use math every day." "The extreme word problem lesson helped me view mathematics differently from seeing that the equations are and can actually be real-world situations and not just useless problems."

And some viewed their work as being that of a mathematician: "We were like mathematicians. Mathematicians look at patterns in mathematical equations and make sense of the patterns to gain a better understanding."

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