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Math in Motion: Bottle Flipping

A S.T.E.M. in Action Activity

By Brad Fulton
Educator of the Year, 2005
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Brad Fulton

Educator of the Year

- ♦ Consultant
- ♦ Educator
- ♦ Author
- ♦ Keynote presenter
- ♦ Teacher trainer
- ♦ Conference speaker

Known throughout the country for motivating and engaging teachers and students, Brad has co-authored over a dozen books that provide easy-to-teach yet mathematically rich activities for busy teachers while teaching full time for over 30 years. In addition, he has co-authored over 40 teacher training manuals full of activities and ideas that help teachers who believe mathematics must be both meaningful and powerful.

Seminar leader and trainer of mathematics teachers

- ♦ 2005 California League of Middle Schools Educator of the Year
- ♦ California Math Council and NCTM national featured presenter
- ♦ Lead trainer for summer teacher training institutes
- ♦ Trainer/consultant for district, county, regional, and national workshops

Author and co-author of mathematics curriculum

- ♦ Simply Great Math Activities series: six books covering all major strands
- ♦ Angle On Geometry Program: over 400 pages of research-based geometry instruction
- ♦ Math Discoveries series: bringing math alive for students in middle schools
- ♦ Teacher training seminar materials handbooks for elementary, middle, and secondary school

Available for workshops, keynote addresses, and conferences

All workshops provide participants with complete, ready-to-use activities that require minimal preparation and give clear and specific directions. Participants also receive journal prompts, homework suggestions, and ideas for extensions and assessment.

Brad's math activities are the best I've seen in 38 years of teaching!
Wayne Dequer, 7th grade math teacher, Arcadia, CA

"I can't begin to tell you how much you have inspired me!"
Sue Bonesteel, Math Dept. Chair, Phoenix, AZ

"Your entire audience was fully involved in math!! When they chatted, they chatted math. Real thinking!"
Brenda McGaffigan, principal, Santa Ana, CA

"Absolutely engaging. I can teach algebra to second graders!"
Lisa Fellers, teacher

Like my activities? How about giving me a favorable rating on the Teachers Pay Teachers website? Four stars would be much appreciated and would help me sleep better at night.

Like me even more? Then please don't make copies for your colleagues. I know it's tempting when they say, "Wow! Groovy activity! Can I have a copy?" But this is how I make my money, and why are they still saying "groovy" anyway?

If we make copies for our friends, can we honestly tell our students not to copy or take things that don't belong to them? (Ouch!)

Discounted site licensed copies are available on the TPT website. Please encourage them to take advantage of this affordable option. Okay?

Thanks and happy teaching,

Brad

I want...

- ☐ a) Effective staff development
- ☐ b) Affordable staff development
- ☐ c) Ongoing staff development
- ☒ d) *ALL OF THE ABOVE!*

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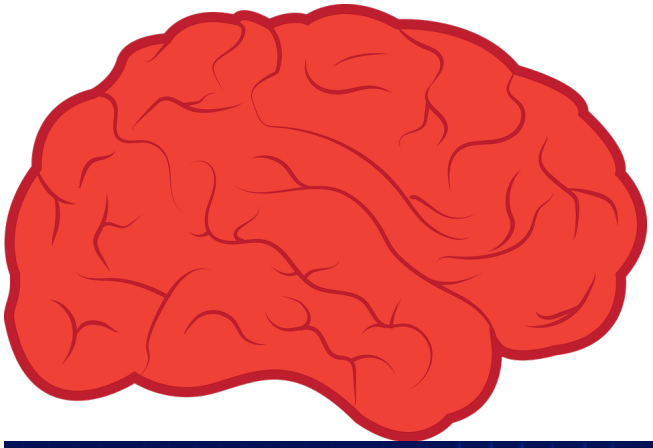
Great DVD presentations offer quality mathematics staff development at a fraction of the cost!

- **Effective because** they are classroom-tested and classroom-proven. These popular DVDs of Brad's trainings have been utilized by teachers throughout the country for years.
- **Affordable because** they are site-licensed. Buy only one copy for your whole school, print as many copies of the handouts as you need.
- **Ongoing because** when you hire new staff, simply hit "play" and the training begins. There's no need to bring back the consultant.

Math in Motion:



When we sit for 20 minutes or longer, blood flow to the brain drops by 10%. At a 15% deficit, a student will fall asleep, pass out, or shoot spit wads to stay awake. If we want to maximize learning, we have to maximize the oxygen to the brain. The "Math in Motion" lessons do this by getting students up and active as they participate in fun, engaging, and mathematically sound lessons.

And these lessons aren't just fun with a little math sprinkled on top. They are grade-level-appropriate lessons that will help students connect to the standards.

S.T.E.M. in Action

As a "S.T.E.M. in Action" lesson, you'll find all four components of a true S.T.E.M. curriculum represented.

Science — Students measure mass and compare the behavior of the liquids as they flip the bottle.

Technology — Students can build a spreadsheet and use it to collect and aggregate their data.

Engineering — Students design an experiment to test whether the mass of water in a bottle affects their success in flipping it.

Math — Students collect data, represent data, and interpret data as well as convert fractions to percentages.

OVERVIEW

Materials:

- ☒ 11 plastic 500mL water bottles
- ☒ activity master

Optional:

- ☐ graphing software

Bottle Flipping

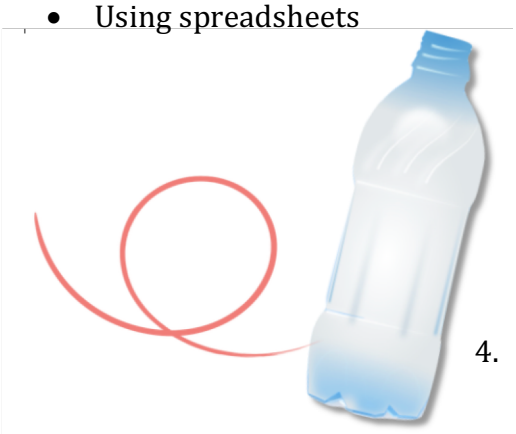
As long as the students are going to flip bottles, let's find the math in it. This measurement and data activity will keep the students so engaged that they'll forget that they are learning rigorous math!

Vocabulary: data, mean, average, mode, range, aggregated data

PROCEDURE

Skills:

- Gathering data
- Analyzing data
- Representing data
- Interpreting data
- Finding central tendencies
- Converting fractions to percents
- Using spreadsheets



1. Prior to the lesson, gather eleven 500mL (16.9 oz.) water bottles.
2. Ask the students if they have flipped bottles before? Who considers themselves an expert bottle flipper? Does the amount of water in the bottle affect their success? What is the ideal amount of water? How would you test this?
3. Students should realize that you would need to flip bottles with different masses of water. To design a good experiment, they will probably need some guidance. You can ask questions to direct them to conclusions such as these:
   a. To draw reliable conclusions, you need lots of data. Thirty samples is a minimum.
   b. Some students are better bottle flippers than others. Thus we should have everyone compete.
   c. We will need to collect data and find averages.
4. Once this is done, you can guide them into the experiment described here.
5. Leave one of the water bottles completely full. The second bottle should only have 450mL. The third one 400mL, the fourth one 350mL, and so on down to the last bottle that will have no water:

500	450	400	350	300
250	200	150	100	50
		0		

6. Set up eleven tables or stations and divide your class into teams. You can create fewer than eleven teams. For example, you might wish to create eight 4-person teams in a class of 32 students. This will allow for empty stations so that students don't have to wait for other teams.

7. Instruct the teams to move to each station. Each person takes a prescribed number of flips (such as three) with the bottle at that station and records the number of flips and the number of times that they landed the bottle upright. This should be recorded on their activity sheet. The data can be aggregated later by hand or with a spreadsheet.

   The number of flips each student takes and the number of students per team will determine not only the length of the lesson and the amount of the data. It will also govern the complexity of the fraction to percent conversions.

   For example, if each person takes 4 flips, it is easy to convert their success rate into percentages of 0%, 25%, 50%, 75%, and 100%. However, as a team of four, they would then have to convert sixteenths into percentages.

   A simpler option would be to have each student take five flips. Thus their results will be 0%, 20%, 40%, 60%, 80% or 100%. Then the team of four would have a total of 20 flips, and each flip represents 5% of the total.

   For older students, you could have them take six flips and have teams of 3, 4, or 5 to make the math more challenging.

8. After each team member has flipped the bottle the required number of times, the team will move to an empty station until they have visited all eleven.

9. Once the students have gathered their data from all eleven stations, they should aggregate the data with the other members of the class. This can be done by adding *all* the team attempts and successes for each station. For example, let's assume six teams have collected this data for the station for 200mL of water:

Vocabulary:
Let's assume that we have a data set of 10%, 13%, 21%, 22%, 42%, 42%, and 54%.

Range: the difference between the highest and lowest members of a set:
54 – 10 = **44**

Mode: the most often occurring data: **42%**

Median: the middle datum: **22%**

Mean: the average, obtained by adding the data and dividing by the number of elements:
(10+13+21+22+42+42+54) ÷7=**29.14%**

My team landed a total of 4 out of 12…

My team landed a total of 7 out of 12…

My team landed a total of 10 out of 12…

My team landed a total of 7 out of 12…

My team landed a total of 5 out of 12…

My team landed a total of 6 out of 12…

Then the aggregate data is 39 out of 72 for 54%.

10. At this point, you can ask them questions about the data that are based on range and central tendencies. What is the range of the successes? What is the mode? What is the median? What is the mean (or average)?

11. This data should then be put in a table like this that the students copy into their notes:

Water: Success rate:

0mL.....0%

50mL.....9%

100mL.....8%

150mL.....11%

200mL.....16%

…and so on.

12. Now that they have gathered, analyzed, and represented the data in a table, they can begin to interpret it. Refer them to the questions in part 2 of the lesson. According to the data, does the amount of water affect the success in bottle flipping? What is the ideal amount of water? If everyone in the school were to take one attempt, how many successes should we expect? This can be a question involving proportional reasoning. For example, if there are 892 students in the school and the best flip percentage was 54%, the problem could be solved with this proportion.

$$\frac{54}{100} = \frac{x}{892}$$

It can also be solved through decimal multiplication:

54% of 892 = .54 x 892 = 481.68

Students must interpret the result of this answer. Can a part of a student flip a bottle? How should we round this answer?

http://bit.ly/aggregateaverage

13. The data can also be aggregated using software such as Google Sheets. The QR code or url on the right will take you to a ready-made spreadsheet. Make a copy of the spreadsheet for your use and you are ready to go.

    If you wish to have your students create the spreadsheet themselves, the instructions on the following page are provided.

Google spreadsheet instructions:

1. In cell A1, type **0mL**
2. In cell B1, type **50mL**
3. In cell C1, type **100mL**
4. In cell D1, type **150mL**
5. In cell E1, type **200mL**
6. In cell F1, type **250mL**
7. In cell G1, type **300mL**
8. In cell H1, type **350mL**
9. In cell I1, type **400mL**
10. In cell J1, type **450mL**
11. In cell K1, type **500mL**
12. In cell A14, type **=average(A2:A13)** This is an equation that calculates the average of the data in column A. *Don't forget to type the equal sign first*. This tells the spreadsheet to calculate the math for you. You will see "#DIV/0!". This means that there is a dividing by zero error. This is occurring because you don't have any data in the cells yet. Don't worry about the error message as it will go away once you enter data.
13. Highlight cells A14 through K14.
14. Hold down the control key and type **R**. This will fill the averaging formula to all the highlighted cells to the right. This is called a "fill right" command.
15. Another way to do this is to select cell A14, click the handle in the lower right corner, and drag this over to cell K14.

16. Each team can now enter data on lines 2 through 13. There is room for 12 teams. If you have less than 12 teams, leave those lines blank. Do not enter zeros for missing teams.
17. If you wish to graph the data in row 14, select cells A14 through K14. Then go to the "Insert" menu and select "Chart". The default chart is a line graph, but you can change that under "Chart type".

Activity master

Bottle Flipping

Name_____

Date_____ Class_____

Visit each station. Take _____ flips of the bottle and record how many times you landed it.

Station: 0mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 50mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 100mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 150mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 200mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 250mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 300mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 350mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 400mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 450mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

Station: 500mL of water

I landed _____ out of _____ flips. This makes _____%.

My team landed a total of _____ out of _____ flips which is _____%

If you liked this activity, you might also like some of the other lessons available in my TeachersPayTeachers store. Simply search for "**Teacher to Teacher Press**".

You can also find many free and inexpensive resources on my personal website, www.tttpress.com. **Be sure to subscribe to receive monthly newsletters and FREE activities.**

Similar ***S.T.E.M. IN ACTION*** activities include:

- *Fidget Spinner Math* – Does the cost of a fidget spinner relate to its performance? An active and engaging math lesson in time measurement, graphing, data collection and analysis for grades 4 – 9.
- *Floss Dancing Math* – Get their blood pumping and their brains engaged in this trendy lesson. Who is our fastest flosser? How long can they keep that pace? Does their rate slow as a linear function? Grades 5 – 9
- *Ramp Races* – An engaging and exciting way to teach students the principles of physics: forces, motion, speed, friction, and more! Grades 6 – 9
- *Spring Action Lab* – A great way to blend math and physics. Students measure, graph, and explore linear functions as they study the relationship between tension forces and gravity. Grades 4 – 9

Feel free to contact me if you have questions or comments or would like to discuss a staff development training or keynote address at your site.

Happy teaching,

Brad