Learning Algebra on the Right Side of the Brain: The Wright Brothers Puzzle was making some readers crazy

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In my original article, Learning Algebra on the Right Side of the Brain, I mentioned that there is a widely-held belief that algebraic exercises, especially word problems, improves problem solving and thinking. That is a strange conclusion since there is no evidence that solving those word problems transfers to other intellectual skills such as problem solving, creativity, or thinking. The evidence from experiments in Educational Psychology clearly shows that solving those word problems only makes one proficient at solving more word problems exactly like those in the textbook.

A closer look at word problems

Seventh-graders were asked to solve this word problem:

"Orville and Wilbur owned a bicycle shop which also sold tricycles. One day, they decided to take an inventory of their stock. They each volunteered to count one item, which would have worked out just fine if one had counted bicycles and the other had counted tricycles. But Orville and Wilbur were both very independent thinkers. Orville counted the number of pedals in the shop and Wilbur counted the number of wheels.

"Orville found that they had 146 pedals in the shop, and Wilbur found that they had 186 wheels. All pedals and wheels were actually parts of either bicycles or tricycles. They were just about to start over with their inventory when their friend Kitty, who was a good problem solver, challenged them to figure out the number of bicycles and tricycles from the inventory they had already done. Can you help the Wright brothers? How many bicycles and tricycles did they have in their shop?..." - (San Jose Mercury News, April 3, 1995).

Some kids perceive this as a fun puzzle and joyfully speculated about possible ways to develop an answer. Other youngsters perceive this word problem as absolute nonsense. They reason: We are talking about the Wright brothers, owners of a bicycle shop in Ohio. The brothers are famous for doing the impossible---inventing a bicycle that flies in the air. Secondly, these thoughtful students (who probably will get "F" in algebra) do not believe that the geniuses who invented the airplane would waste valuable hours counting wheels and pedals when the simple solution is to count bicycles and tricycles. Surely these intellectual giants have something better to do with their time.

The Wright Brothers Puzzle was making some readers crazy

I received e-mail asking me: What is the answer to the Wright Brothers puzzle? The difficulty is this: I had no ready-made answer because there was none offered in the original newspaper article in the San Jose Mercury News. So I began to doodle with the puzzle in an attempt to develop an "answer."

Doodle #1

My first thought was that this may be an apple and oranges issue from elementary arithmetic. The bicycles are the apples and the tricycles are the oranges. Standard school arithmetic tells us that we cannot perform arithmetic with apples and oranges. Why not? Well, if we add 2 apples and 2 oranges, what do we have? 4 pieces of fruit, which seems OK to me, but 4 pieces of fruit does not tell us what kind of fruit. I put the apples and oranges issue aside for the moment and tried a different strategy.

Doodle #2

How about simultaneous equations, one for the wheels and one for the pedals? After reviewing the procedure for solving simultaneous equations in my algebra textbook, and playing with bicycles and tricycles with many different equations, nothing seemed to work.

Doodle #3

This was becoming an embarrassment. I presented a puzzle without knowing the answer in advance. In the legal profession one learns never to ask a question of a witness in court unless you know the answer in advance.

There has to be an answer and it has to be simple because the puzzle was created for students in elementary school. But what was it?

I decided that with trial and error, I could discover the answer of how many bicycles and tricycles were in the Wright Brothers inventory, and then work backwards to find an algebraic procedure to explain how I found the "answer." After all, the entire idea of the puzzle is to give young students a chance to apply some algebra to solve a problem.

Well, by trial and error, I discovered that 33 bicycles and 40 tricycles produced, for bicycles and tricycles together, 186 wheels and 146 pedals. So far, so good! Now what? I have the "answer," but where is the algebra hiding?

Doodle #4

I stumbled upon a clue: If I subtracted pedals from wheels (i.e., 186 wheels - 146 pedals = 40), I get the number of tricycles in the shop, which is 40. Could this be a quirk, or is it an authentic lead to a formula for finding the number of tricycles? Let's doodle:

Number of Tricycles

Wheels - Pedals =

One 3 - 2 = 1

Two 6 - 4 = 2

Three 9 - 6 = 3

Four 12 - 8 = 4

Aha! There is a pattern. The number of tricycles equals wheels minus pedals or in algebraic short-hand:

$$W - P = N$$

Let's test the validity of the formula with 186 wheels and 146 pedals from bicycles and tricycles in the Wright brothers inventory.

186 - 146 = 40 Tricycles

Aha again! It worked! Now, if we have 40 tricycles and we know the total number of tricycles and bicycles in the shop is 73, it is easy to find the number of bicycles: 73 - 40 = 33. But, the original problem did not mention the total number of 73. Now What?

If we have 40 tricycles, then the wheels are 3 times 40 = 120 and pedals are 2 times 40 = 80. Since the total number of wheels is 186 - 120 tricycles wheels = 66 wheels that must belong to bicycles. Since each bicycles has two wheels, there must be 66 / 2 = 33 bicycles in the shop.

Again, so far, so good!

Doodle #5

Now, can it be that there is also a pattern for finding the number of bicycles? Let's play with it! Let's doodle!

Number of bicycles

Wheels + Pedals =
One 2 + 2 = 4
Two 4 + 4 = 8
Three 6 + 6 = 12

Yes! I see a pattern for finding the number of bicycles given wheels and pedals. It is this: Wheels plus pedals divided by 4, or in algebraic short-hand:

(W + P) / 4

Let's apply the formula to the original problem presented in the San Jose Mercury News.

(186 + 146) / 4 =
332 / 4 = 83 Bicycles

Oh! Oh! It did not work! Why not? The reason is that I was trying to do arithmetic with apples and oranges, or in this case, bicycles and tricycles.

The formula will work, but only if we have wheels and pedals from bicycles—not bicycles and tricycles.

Doodle #6

But wait! The strategy worked for tricycles but not bicycles. Why not? Remember, the total number of wheels for both bicycles and tricycles was 186 minus the total number of pedals of 146 equalled 40, the number of tricycles. Here we mix apples and oranges and yet it works. How come?

Example #1

The solution to the mystery is in adding and subtracting like this:

Number of tricycles Wheels - Pedals =
One 3 - 2 = 1
Now let's include:
One bicycle 2 2
Total number of both bicycles and tricycles:
5 - 4 = 1

Notice that adding a constant, in this case a 2, to tricycle wheels and pedals does not change the outcome.

Example #2

Wheels - Pedals =
One tricycle 3 - 2 = 1
Two bicycles 4 4
Total 7 - 6 = 1
Adding a constant of 4 to each variable does not change the outcome.
Example #3
Wheels - Pedals =
Two tricycles 6 - 4 = 2
Two bicycles 4 4
Total 10 - 8 = 2

In arithmetic, adding a constant to variables does not change the outcome.

Grand Summary

I strongly recommend that students be encouraged to doodle or play with information rather than merely duplicate it to pass a school test. Algebra is an excellent example of information that most students would consider too "sacred" to tinker with. Students may also image that professional mathematicians, engineers and scientists dare not tinker with information. Students may imagine that when problems are encountered, it is "obvious" to the professional which mathematical tool will solve the problem.

The reality is that there is extensive "messing around" with mathematical tools in an effort to find something that fits---something that works. Almost nothing in the real world is obvious or transparent. Science, medicine, engineering and the law are all controversial and open to multiple interpretations.

The Wright Brothers puzzle is a marvelous example of an opportunity to "mess around," "tinker with," and "play with" information. I invite my readers to doodle on their own and come up with alternate ways of coping with the bicycle and tricycle problem.

Please share your findings with me. My e-mail is: tprworld@aol.com

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