

## MARTIN GARDNER'S WORD MAGIC ENTHRALLS BROAD RIPPLE TEENS

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Butler University was host on September 18, 2009 to 25 students of Peggy Boulden's class from Broad Ripple High School in Indianapolis. The students were all mathematically astute and we wanted to show them something new and decided to present a Martin Gardner magic effect.

The effect is an adaptation of Gardner's *Word Ways* article "An Amazing Spelling Trick" (Feb. 09). To personalize the trick for the students we had supplied sets of alphabet cards in two groups: one with ten cards that spelled BROAD twice and the other with twelve cards that spelled RIPPLE twice. Initially the sets are arranged in order. Take the first set (placing the second set aside for the moment) and cut it one or more times. Hold the packet face down and deal five cards to form a pile, thereby reversing their order. Put the remaining five cards face down to form a second pile alongside the pile of cards just dealt. We continue according to Gardner:

Now you are going to spell the words in the phrase LAST TWO CARDS MATCH. Pick up either pile and spell the letter L, the first letter of LAST, by moving one card from the top of the pile to the bottom. Replace the pile on the table alongside the other one. Again, randomly select one of the two piles. Pick it up and move a card from top to bottom to spell A. Replace the pile, then pick up either pile to spell S. Do the same for T.

You now have two piles face down on the table. Remove the top cards of each pile. Without showing their faces, put the face-down pair to a vacant spot on the table, one card overlapping the other.

Repeat the random procedure for selecting a pile and spelling T, then W and O. After spelling TWO, again remove the top cards of the two piles, and place them aside, face down, near the pair previously put aside.

In the same way randomly select piles for spelling CARDS and MATCH. After each spelling of a word put the top cards of the two piles to one side, face down by the other pairs.

Two face-down cards remain on the table. Turn them over. Surprise! In spite of all the random choices, the cards match! The prediction, "Last two cards match," has been fulfilled.

The trick is not over. We continue similarly with the set of twelve cards. Cut several times and count out six cards face down placed down next to the other stack of six. This time we spell the five words EVERY PAIR, FINALLY, SHALL AGREE.

Once again remove the top cards in each of the two stacks after randomly spelling each of the five words. Of course the last pair will turn out to be matched letters. In fact every pair in both the BROAD set and RIPPLE set can now be shown to match!

How does the trick work? Most of the students were familiar with modular arithmetic and could understand the working principle involved. First the repeated cutting does not change the order in either set. The counting out reversal of half the cards in each of the two sets arms the trick. For BROAD, we choose four words of varying length so that the number of letters in the first word  $\equiv 4 \pmod{5}$ , in the second  $\equiv 3 \pmod{4}$ , in the third  $\equiv 2 \pmod{3}$ , and in the fourth  $\equiv 1 \pmod{2}$ . Notice that the four words LAST TWO CARDS MATCH meet this requirement. For the six letter RIPPLE double set we start with a first word (here EVERY) whose length  $\equiv 5 \pmod{6}$  and continue down the modular path.