Math Magic Trick 3

Start:

Teacher selects a person and supplies them with a pile of a pile of chips, coins or, pebbles or any other kind of small objects. After explaining the steps below the teacher leaves the person alone so that the teacher does not observe the person manipulating the objects.

		Piles	Product	Total
Step 1:	The person is take away some of the objects and to write down how many objects are left in the one big pile that they have. (Note: Discard the objects pulled out.)	example: 6		
Step 2:	Divide the pile into two smaller piles (piles do not have to have the same number in each new pile)	4 & 2		
Step 3:	Mentally multiply the number of objects in each pile together to get an answer called total		(8)	8
Step 4:	Divide one of the new piles into two smaller piles	1 & 3		
Step 5:	Mentally multiply the number of objects in the new pile together to get an answer and add this to the previous total		(3)	11
Step 6:	Repeat Steps 4) and Steps 5) until no smaller piles are possible	1 & 2	(2)	13
		1 & 1	(1)	14
	from step 2) the pile of that had 2 in it:	1 & 1	(1)	15

Step 7) When the person is done the teacher asks for the final number total (15 in this example)

Mental Trick:

Based on this answer the teacher tells the person how many objects were in the beginning pile that the person wrote down on the piece of paper.

How teacher gets the answer:

Double the persons answer (15 x 2 = 30) and then find two consecutive positive integers that multiply to be this product (5 and 6). The larger of the numbers is the answer.

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Math Magic Trick continued

Why it works:

Here is the proof that uses mathematical induction. Assume we start with N=2 chips. The only way to split such a pile is to halve it into two piles of 1 chip each. The computed number is just 1. Of course it's independent of how you split the pile; for there is just one way to perform this feat. Note that starting with N=1 leads to the number 0. We split nothing. One can argue it's the same as having a pile with 0 chips which contributes 0 to the total regardless of the number of chips in other piles. Now, assume that the result has been established for all numbers less than N and let there be N>2 chips in the original pile. Split it into two with n and m chips, respectively. We have n,m>0 and
n+m = N. By our assumption, proceeding with the first pile we'll get the number n(n-1)/2 regardless of how we actually proceed. For the second pile, we'll get m(m-1)/2.
The total is mn + n(n-1)/2 + m(m-1)/2 which, after a series of simplifications, yields
(m+n)(m+n-1)/2 = N(N-1)/2
which is dependent on neither original nor consecutive splits and is exactly the number we expected.
i.e. N(N-1)/2 = the Total