Constructing a Square an Ancient Indian Way Activity

Overview

In this activity, the students will model constructing a square with a method similar to one used by people in ancient India to build a fire altar. The activity works best with the students working in pairs.

Original Text

This activity follows closely Paragraph 1.5 of the *Baudhāyana-śulba-sūtra*, in the translation from Sen and Bag (Sen, S.N., and A.K. Bag. *The Śulbasūtras*. Indian National Science Academy, 1983).

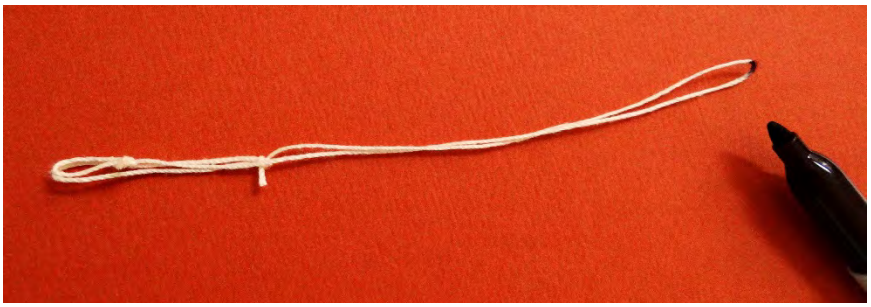
> *Now another (method). Ties are made at both ends of a cord twice the measure and a mark I given at the middle. This (halving of the cord) is for the east-west line (that is, the side of the required square). In the other half (cord) at a point shorter by one-fourth, a mark is given; this is the* nyañcana *(mark). (Then) a mark is given at the middle (of the same half cord) for purposes of (fixing) the corners (of the square). With the two ties fastened to the two ends of the east-west line* (prythyā), *the cord is to be stretched towards the south by the* nyañcana *(mark); the middle mark (of the half cord) determines the western and eastern corners (of the square).*

Materials for each pair of students

- 3 thumbtacks or push pins
- Square or rectangular piece of corrugated cardboard, e.g. the top of a pizza box, or a flat piece of styrofoam
- Piece of string – length should be double the length of the desired side of the square plus some extra for making loops on each end (2 to 4 inches for each loop, depending on the fine motor skills of the students)
- Straightedge
- Marker or pen

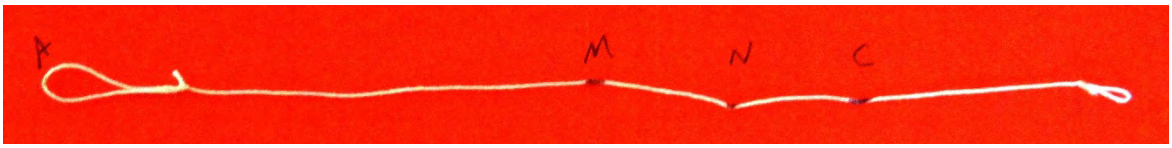
Instructions

1. Tie a loop at each end of the string. (Instructions for tying a perfection loop knot can be found at http://www.netknots.com/fishing_knots/perfection-loop/ .)
2. Fold the string in half, and using the marker, mark the midpoint *M* of the string. (The constructed square will have side length equal to the length of the folded string.)

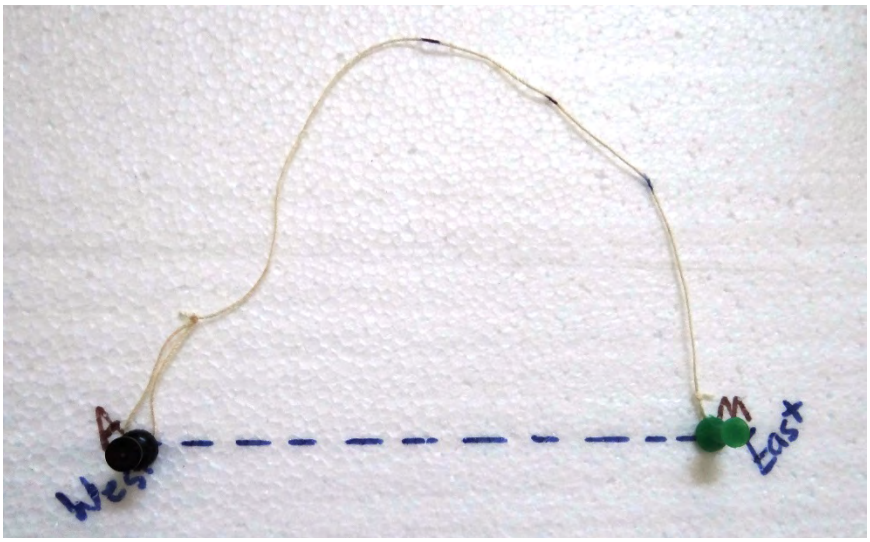


3. Using the straightedge, trace a line segment $\overline{AM}$ with length the same as half of the string. This segment $\overline{AM}$ will be the East-West line of the square.

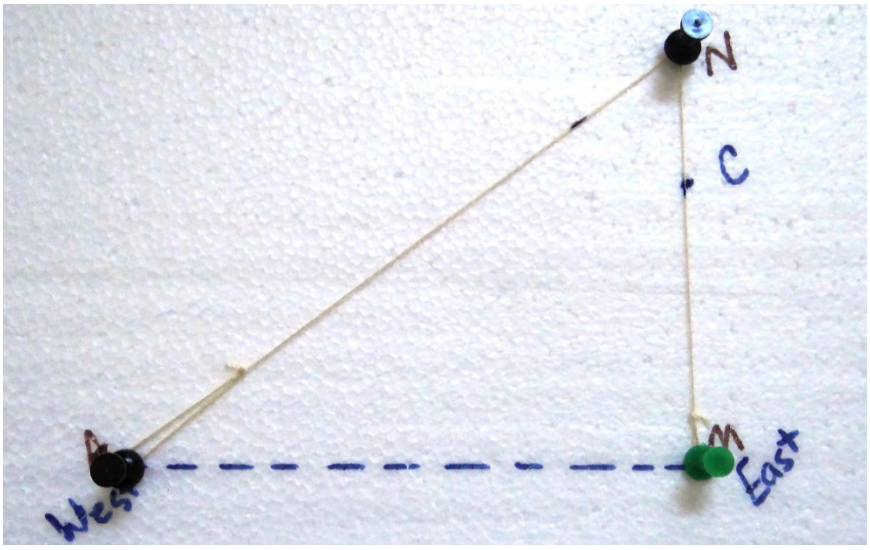
4. Fold one-half of the string in half, and using the marker, mark the midpoint of that half of the string, *C*. This point *C* will be used to construct the corners of the square.
5. With the same half of the string, fold it in half again and mark the point *N* that is midway between *M* and *C,* i.e. 1/4 of the way past the midpoint of the entire string. In the *Baudhāyana-śulba-sūtra*, this point *N* was called the *nyañcana* (pronounced nyan-cha-na).



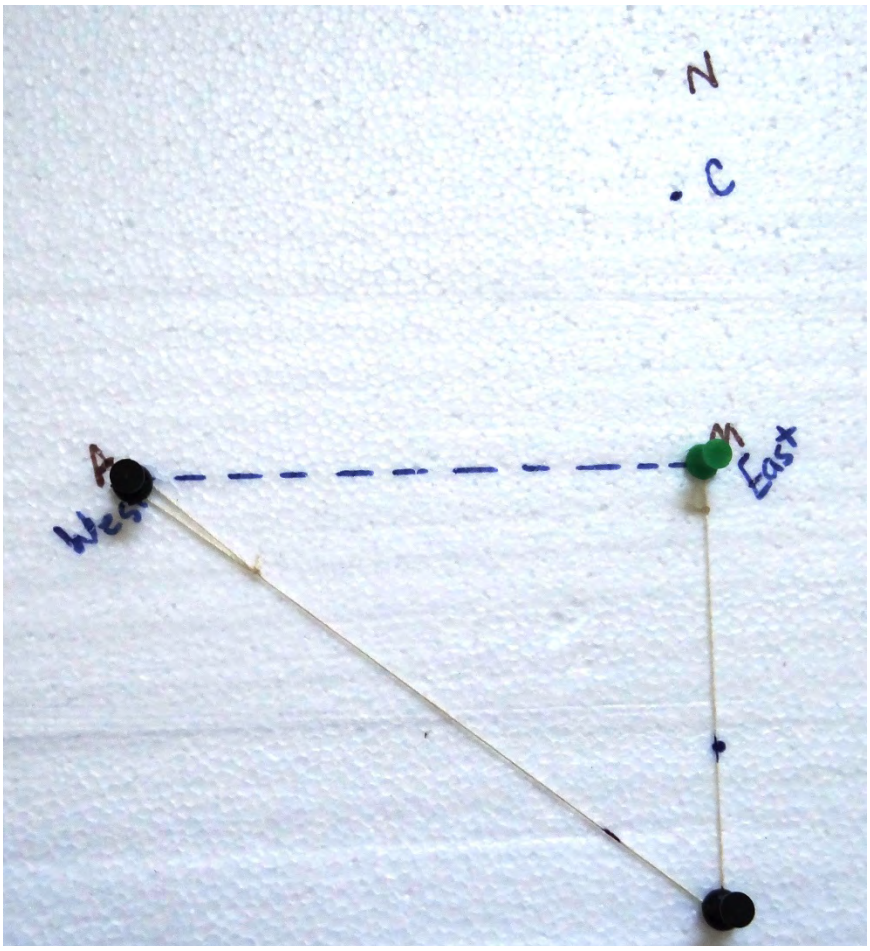
6. With a pushpin through each loop at the ends of the string, place the pins on the ends of the East-West line segment, $\overline{AM}$.



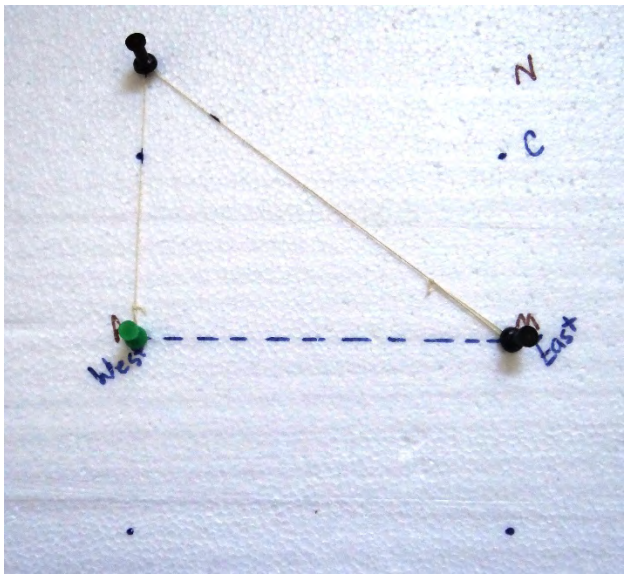
7. Holding the string at the ¼ *nyañcana* point *N*, pull the string upwards until it is taut. Use a pushpin to hold the string taut at *N*. Mark on the background the location of the point *C*.



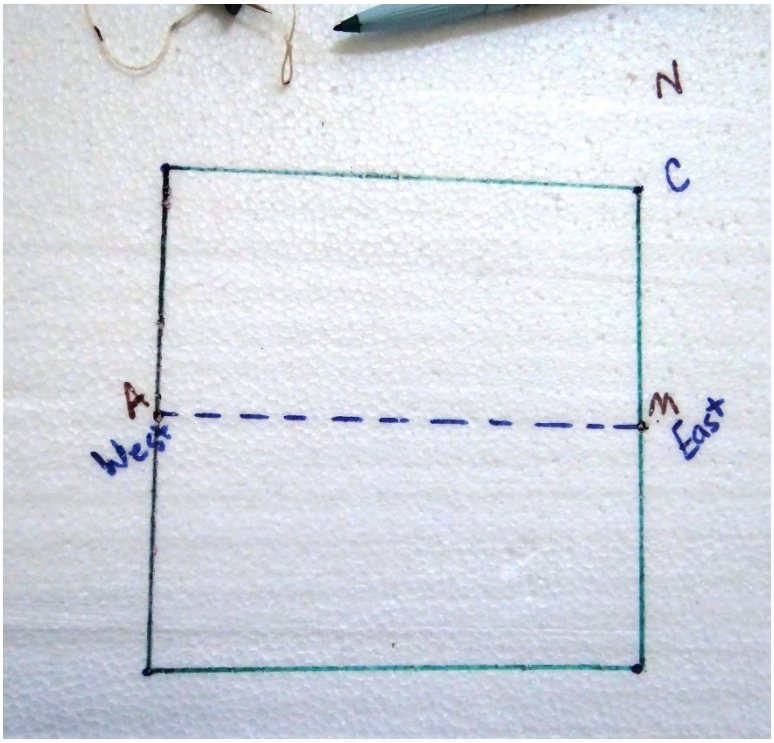
8. Repeat step 7, by pulling the string downwards.



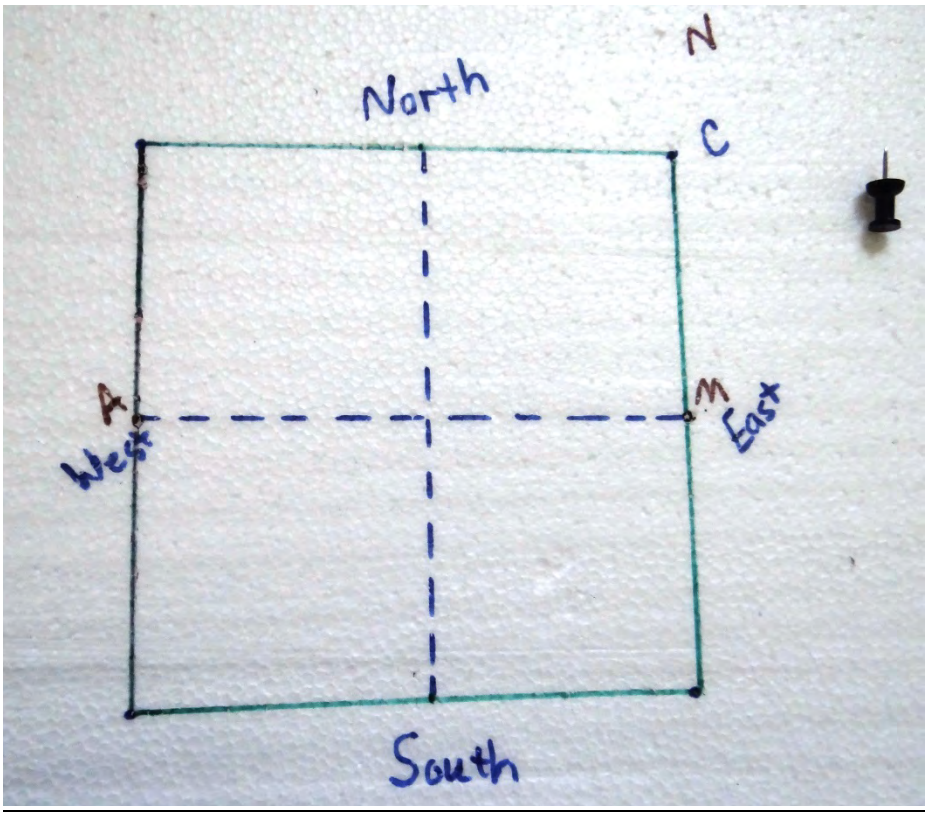
9. Change places with the ends of the string on the East-West line segment, $\overline{AM}$. Repeat steps 7 and 8 to construct the other two corners of the square.



10. Draw the square by using the straightedge to connect the four corner points.



11. If desired, use the cord to find the midpoints of the top and bottom of the square to create a North-South line.



Follow-up Activity

Have the students prove that the result is actually a square, first by proving it is a rhombus (with each side having the length of half the string) and then proving that each interior angle is a right angle. (Hint: Use the converse of the Pythagorean Theorem since the triangle formed in Steps 6 and 7 is a 3-4-5 triangle. To see that the triangle *AMN* is a right triangle, start be letting the length of $\overline{AM}$ be *a.* Then the string has length 2*a* and the two sides of the triangle it forms in Step 7 have lengths $\frac{5}{4}a$ and $\frac{3}{4}a$, respectively.)

Notes

- The string should not be stretchy.
- Loops on the ends of the string should be fixed so they won't slide.
- When making circles, the pin should be held steady but not flush against the cardboard so that the loops can move freely about the shank of the pin.
- Watch out for the sharp ends of the pins poking through the cardboard or styrofoam.
- Common Core Standard G.CO.12 recommends making formal geometric constructions with a variety of tools and methods.
- This activity is included in *More Classroom Activities Based on Ancient Indian Rope Geometry,* by Dr. Cynthia Huffman and Dr. Scott Thuong, MAA *Convergence* (May 2018).