Tricky String Triangles: Do They Always Work?

Introduction:
This lesson covers objectives in the geometry and measurement strands of the New York State standards for Mathematics. The students will use manipulatives in cooperative groups to discover the formula for determining the sides of a triangle. Each group will work toward the understanding that there are some lengths of string that cannot be used to create a triangle and from the pattern they see, generate a formula for deciding if three given lengths of string can form a triangle. One day of instruction is needed for this lesson.

New York State Standards:
Mathematics, Science, and Technology - Standard 3
Students will:
- understand the concepts of and become proficient with the skills of mathematics;
- communicate and reason mathematically;
- become problem solvers by using appropriate tools and strategies;
through the integrated study of number sense and operations, algebra, geometry, measurement, and statistics and probability.

Geometry Strand
Students will use visualization and spatial reasoning to analyze characteristics and properties of geometric shapes.
5.G.1 Calculate the perimeter of regular and irregular polygons
Students will identify and justify geometric relationships, formally and informally.
5.G.3 Identify the ratio of corresponding sides of similar triangles
5.G.6 Classify triangles by properties of their angles and sides

Measurement Strand
Students will determine what can be measured and how, using appropriate methods and formulas.
5.M.3 Measure to the nearest centimeter

Objectives
1. The students will be able to utilize the formula for determining the sides of a triangle.
2. The students will measure the sides of a triangle to the nearest centimeter.
3. The students will be able to organize the data of five triangles.

Instructional Protocol
This is a hands on lesson created to determine whether or not a triangle can be formed from any three given sides. The teacher will guide the students by providing a worksheet to follow and circulating about the groups, offering hints where needed. Each student will turn in the worksheet with their data and an explanation of what they found. Beforehand, the teacher will create the appropriate bags of cut yarn for each part of the activity.
Materials:
Yarn (red, green, blue, orange)
Scissors
Sandwich bags
Rulers
Tricky String Triangle Worksheet

1. Assign five groups of students. Give each group a piece of red yard of any length (long enough to cut into three pieces of decent length for manipulation) and the Tricky String Triangles worksheet. Give the following directions to the groups: “Cut your yarn into three pieces of any size you want. Then create a triangle from those three pieces. You must use the entire string given to you, but you may arrange the three pieces in any way that you want. Then measure the lengths of each side rounding to the nearest centimeter.” Circulate about the room and check to see if there is a group that cannot make a triangle from the pieces they made. If so, point this out to the whole class.

2. Give these directions: “Now, I am going to give each group a bag of strings that I cut ahead of time. Check to see if you can make a triangle from these strings. Then measure the strings in centimeters and record the lengths on the worksheet I gave you.” Pass out the bags of precut green strings. All of these sets of string should not create triangles. Below are some examples of measurements that will not work to create triangles.

<table>
<thead>
<tr>
<th>Measurements that will not create triangles</th>
</tr>
</thead>
<tbody>
<tr>
<td>15, 17, 37</td>
</tr>
<tr>
<td>15, 17, 32</td>
</tr>
<tr>
<td>12, 25, 40</td>
</tr>
<tr>
<td>20, 23, 50</td>
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<tr>
<td>13, 19, 38</td>
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<tr>
<td>10, 20, 30</td>
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</tbody>
</table>

Allow spies from each group to check out the other groups measurements to see if they can find a pattern.

3. Pass out the bags of blue and orange strings and give the following directions: “Now, I am going to give you a bag where the two blue strings are two sides of your triangle and you have to pick the orange string that works to create a real triangle. Then measure each of the sides of your triangle and record this on your worksheet. When you are done with the bag I gave you, trade with another group and do the same with the new bag of strings, until you have checked all five bags. Then try to answer the questions on the back of the worksheet.” Circulate around the room giving hints about how to look at the measurements of the sides. In the end the students should understand that in order to create a triangle the sum of the lengths of the smaller two sides must be greater than the length of the longest side. (It is important to put extra emphasis on the fact that the sum and the longer side cannot be equal.)
<table>
<thead>
<tr>
<th>Bag #</th>
<th>Lengths of Blue Strings</th>
<th>Lengths of Orange String that works</th>
<th>Length of Decoy Orange Strings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15, 20</td>
<td>17</td>
<td>37, 40</td>
</tr>
<tr>
<td>2</td>
<td>12, 25</td>
<td>28</td>
<td>40, 42</td>
</tr>
<tr>
<td>3</td>
<td>16, 20</td>
<td>12</td>
<td>45, 50</td>
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<tr>
<td>4</td>
<td>20, 23</td>
<td>25</td>
<td>45, 47</td>
</tr>
<tr>
<td>5</td>
<td>13, 24</td>
<td>19</td>
<td>40, 43</td>
</tr>
</tbody>
</table>

**Extension Activity:**
Have students look at the possibilities for other polygons. Can they make a rule for a quadrilateral or pentagon etc.?
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1. Did the three red strings create a triangle?   Yes   No

2. Give the measurements of the three red strings (round to the nearest centimeter).
   
3. Record the data for your green strings.

<table>
<thead>
<tr>
<th>Bag #</th>
<th>Length of Shortest String (cm)</th>
<th>Length of Middle String (cm)</th>
<th>Length of Longest String (cm)</th>
<th>Could you make a triangle?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes  No</td>
</tr>
</tbody>
</table>

4. Record the data for each set of blue and orange strings.

<table>
<thead>
<tr>
<th>Bag #</th>
<th>Length of Blue String (cm)</th>
<th>Length of Blue String (cm)</th>
<th>Length of Correct Orange String (cm)</th>
<th>Length of Incorrect Orange String (cm)</th>
<th>Length of Incorrect Orange String (cm)</th>
</tr>
</thead>
<tbody>
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</table>
5. Describe the pattern you see that relates the sides of each triangle.

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6. Write a rule for deciding if three lengths of string will create a triangle.

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