# Pythagoras and Pele; Gooooooooooooaaaaaaaaa… (to be continued)

02/04/2011 BY GEOFF

…ooooaaaaallllll!

There's about a hundred different ways you could use the following artifacts to construct a lesson around **Pythagorean's Theorem**. So I'll just toss out all the artifacts and let you, esteemed teacher, **take it from there**. I'd love to get feedback and suggestions on how to implement these materials in the comments below.

**Artifacts**

Use any combination of the following.

This video from This Old House in which two small girls assist with the construction of a pint-sized soccer net: How to Build a Soccer Goal | Video | Family Projects | This Old House.

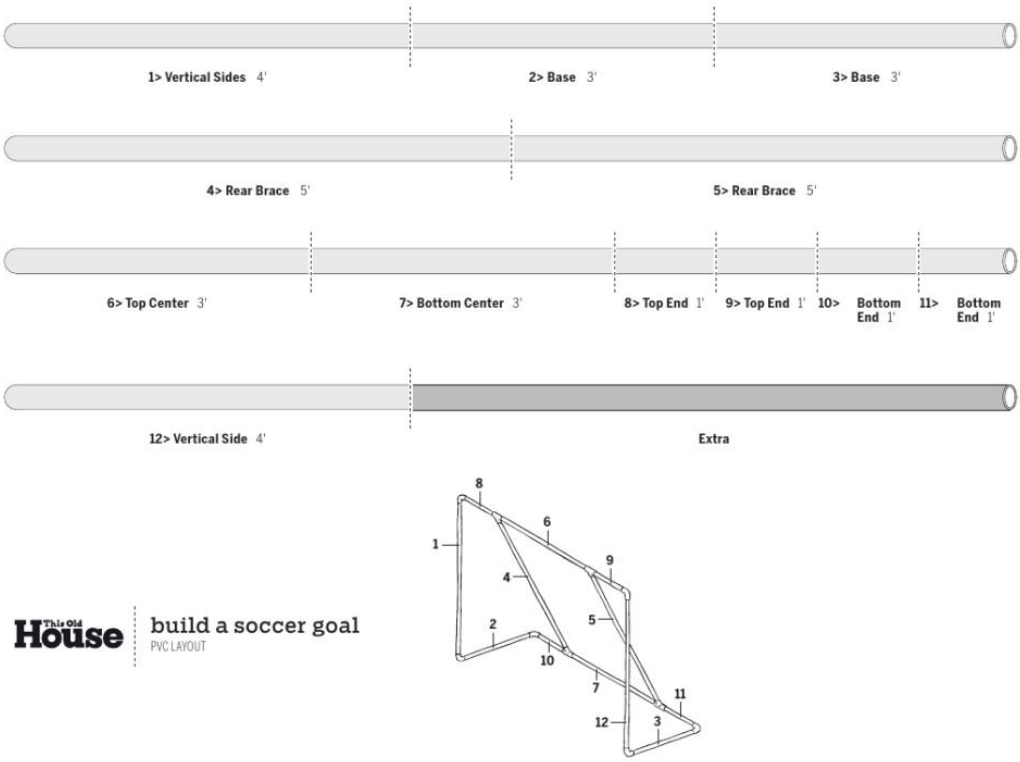
The screen shot of the girl holding up one of the 5 most beautiful right triangles I have ever seen.  (note: before math geeks go berserk, I *know* it's *technically* not a right triangle with the extra bit off to the side, but still.)

# How to Build a Soccer Goal

This Old House television

Shopping List | Tools List

The cutting diagram given by This Old House.




This list of regulation soccer goal heights (from http://www.usyouthsoccer.org).

KWIKGOAL®

## Recommended Goal Sizes and Game Format

| AGE | GOAL SIZE | FIELD WIDTH MIN | FIELD WIDTH MAX | FIELD LENGTH MIN | FIELD LENGTH MAX | PLAYERS PER TEAM MIN | BALL SIZE MAX |
|---|---|---|---|---|---|---|---|
| U-6/U-7 | 4'H x 6'W | 15 yds | 20 yds | 20 yds | 30 yds | 3-v-3 | 3 |
| U-8 | Up to 6½'H x 12'W | 20 yds | 30 yds | 40 yds | 50 yds | 4-v-4 | 3 |
| U-9 | Up to 6½'H x 18½'W | 30 yds | 35 yds | 40 yds | 50 yds | 6-v-6 | 4 |
| U-10 | Up to 8'H x 24'W | 40 yds | 50 yds | 70 yds | 80 yds | 8-v-8 | 4 |
| U-11 | Up to 8'H x 24'W | 40 yds | 50 yds | 70 yds | 80 yds | 9-v-9 | 4 |
| U-12 | Up to 8'H x 24'W | 40 yds | 55 yds | 90 yds | 100 yds | 11-v-11 | 5 |
| U-13 | 8'H x 24'W | 50 yds | 60 yds | 100 yds | 110 yds | 11-v-11 | 5 |
| INT'L & Seniors | 8'H x 24'W | 70 yds | 80 yds | 110 yds | 120 yds | 11-v-11 | 5 |



This Lowes price for 1"x10' PVC pipe. ($2.72) Optional: PVC pipe connectors (Ts and Ls)


**Guiding Questions**

- Can we do this?
- How much netting will they/we need?
- How much PVC Pipe would we need to make a goal of each size?
- What about those connectors, how many of those will we need, and which kind?
- What will the cost be?

You can pretty much tailor this exercise to whatever your class needs. Personally I like the simple netting question and perhaps extending it with the "**goals of each size**" question, which would involve **ratios** more than

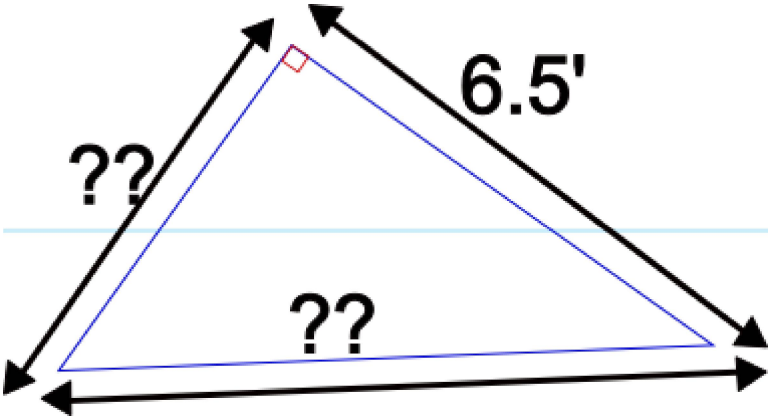
Pythagorean Theorem per se. So let's tackle those.

**Suggested Activities**

Why not have the **students build the soccer goals**? Contact a local soccer club for various age groups and ask if they'd like a few PVC pipe soccer goals for their practice fields. Assign each student group a different age group goal requirements. Now you've got a **rigorous math activity** that will get the **students engaged** with **hands-on construction** and really **impress your administrator** for adding a **sprinkling of community service**.

**Solutions**

For the U8 (under 8) age group, we know the following, although this might be a good time for some **Socratic discussion** on where the "6 1/2' (height)" should go and if that "12' (width)" should go anywhere. Some **manipulation of objects** would do well here.




At this point, you can either choose to **keep it proportional** to the This Old House goal or **mandate** the depth of the soccer net (for more of a Pythagorean approach). I'll choose to keep it proportional to *TOH*, where they make a 3-4-5 right triangle.

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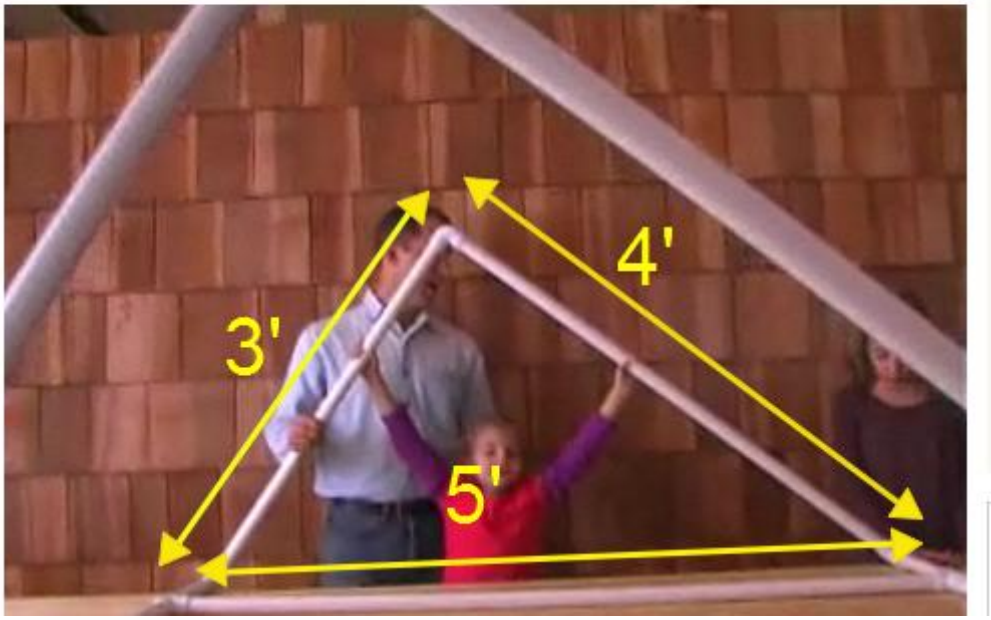
Shopping List  Tools List




To find the missing leg we can set up a proportion.

$$\frac{height\ of\ U8\ goal}{height\ of\ TOH\ goal} = \frac{depth\ of\ U8\ goal}{depth\ of\ TOH\ goal}$$

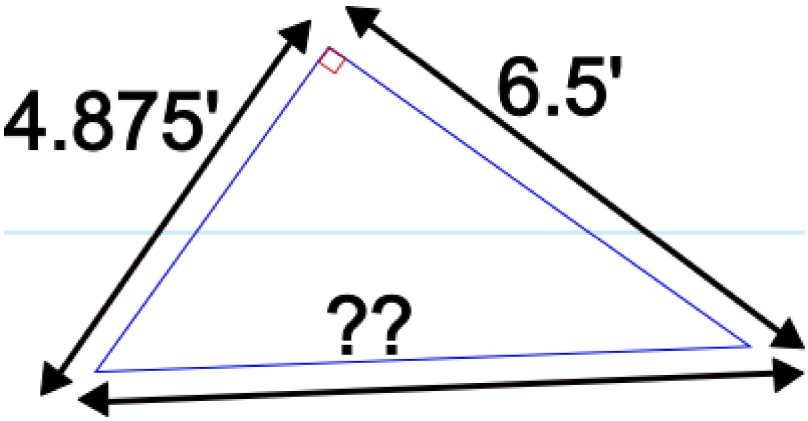
$$\frac{6.5'}{4'} = \frac{x}{3'}$$

$$\frac{6.5'}{4'} \times \frac{x}{3'}$$

$$19.5 = 4x$$

$$x = 4.875'$$

At this point you can either make it a Pythagorean Theorem problem or proportionalize it again. Let's do Pythagorean Theorem.



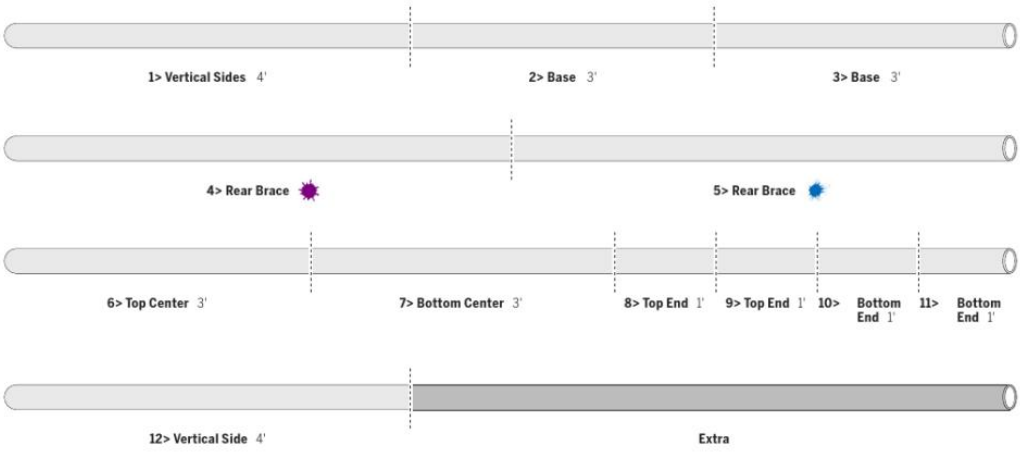

$$C = \sqrt{(4)^2 + (4.875)^2}$$

$$C \approx 6.3'$$

This is for the U8 (and U9) goals, and similar methodology could be used to construct the other goals.

**Comments:**

- Given the exhaustiveness of the *This Old House* episode and supplementary materials, you don't *really* have to use Pythagorean's Theorem for these problems. So they may need to be teacher "mangled" like this.

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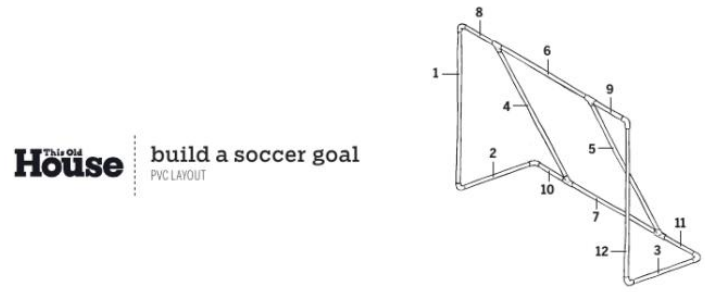


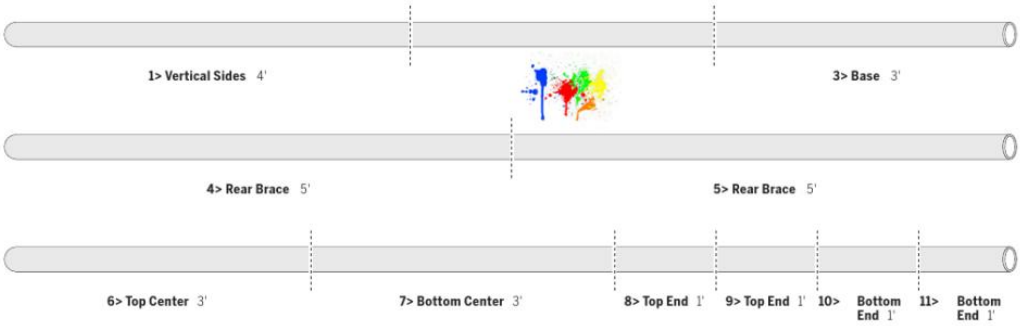



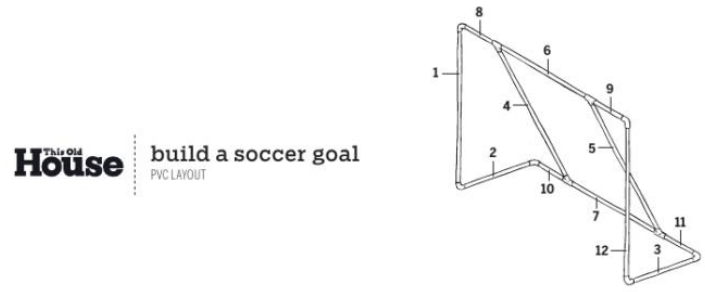


- Even without Pythagorean's Theorem you have to be able to use proportion. And had I answered the "**how much netting?**" question, that would take into account **area**.

- Here's a fun one that *always* seems to trip up students: we increase the goal size by X%. Does that mean we would need to **increase the netting by X%?**
- **[Commentary Alert!]** The last two bullet points speaks to one of the main criticisms of Project Based Learning: that it's hard to *cover* everything. While there's merit to that statement, in this one project, we touched upon **Pythagorean Theorem**, **Proportion**, **Proportional Area**, **Percentages**, and **Area**. If you're looking at **five** major topics covered in – what, a week and a half? **– that's pretty good coverage**.
- The *TOH* website suggests it costs about $50 (and 2 hours) to construct their tyke-sized goal, but I wonder if that price could come down if we're building multiple goals. The cement could be used multiple times for instance.
- The *This Old House* Family Projects portion of their website contains a wealth of potential projects. I'm sure we'll be revisiting some of them on **Emergent Math**, but take a look around yourself. You might be inspired by some of the stuff on there. For your class and your home.