

# Pirate Treasure Maps (and other vector addition teaching activities for High School Students)

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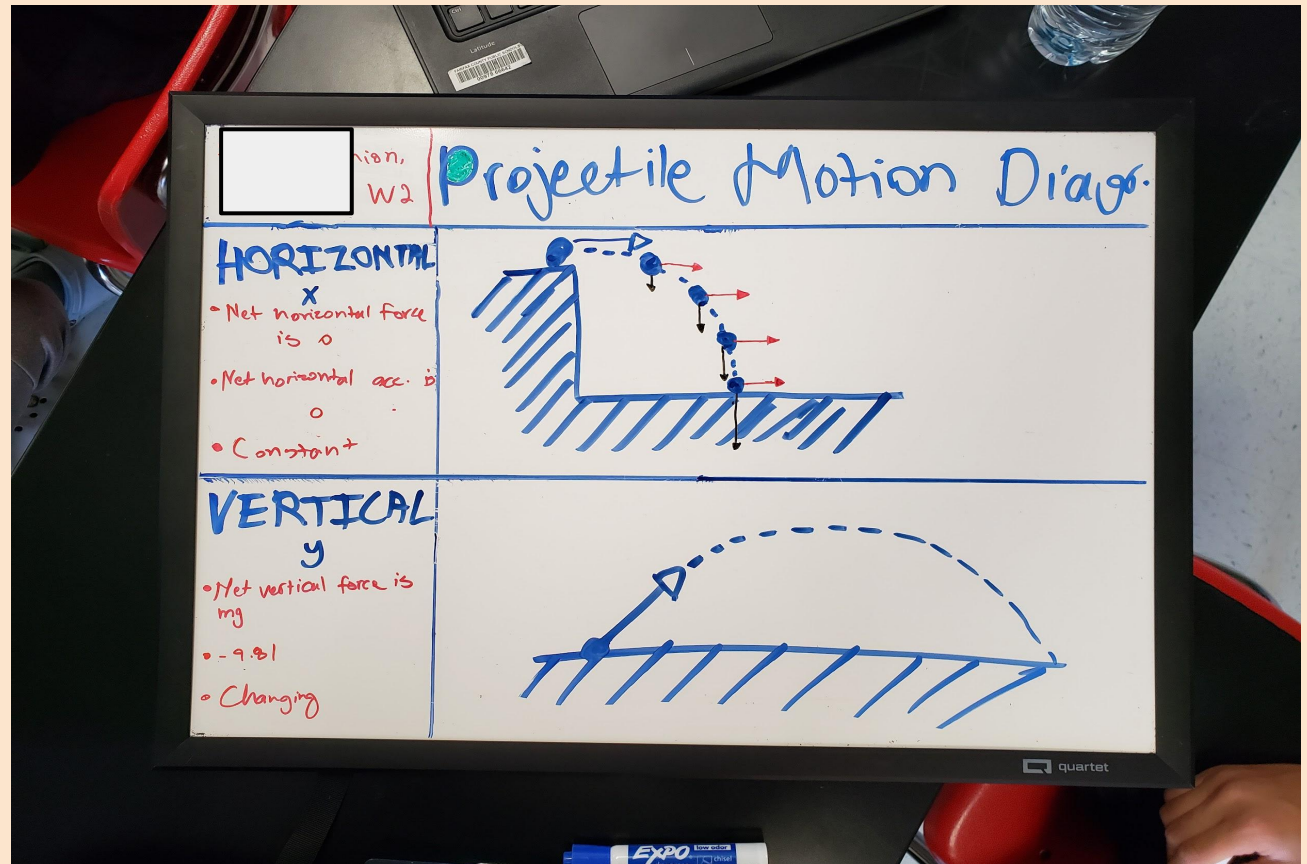
# Abstract:

Vector addition/subtraction seems simple, but High School physics students seem to struggle. Three somewhat time intensive activities will be presented for High School students:

- 1) colored masking tape,
- 2) pre-made lengths of line (Pythagorean Triples several meters long), and
- 3) Pirate Treasure Maps. The Pirate Treasure Map activity is extended to review the cartesian coordinate system, and to generalize the idea of a coordinate system.

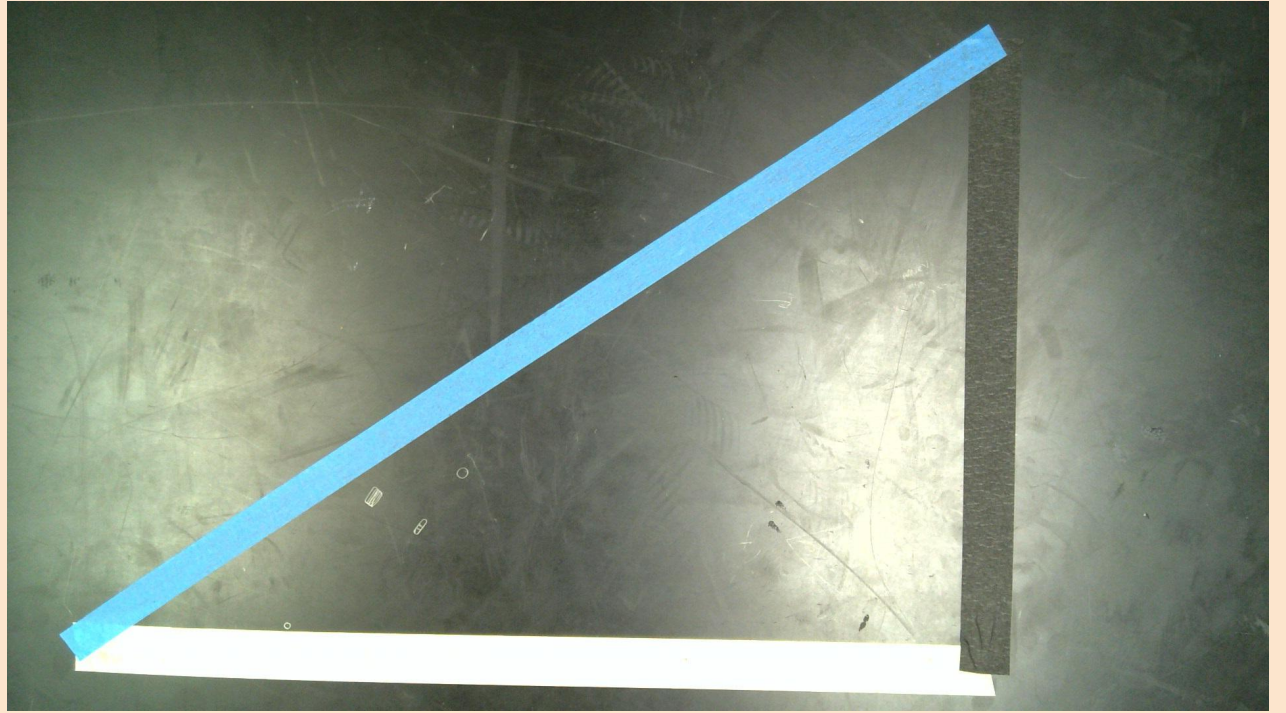
# Goal:

Have students apply their vector proficiencies later on.

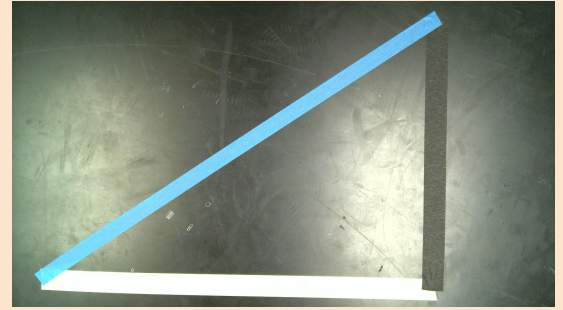


Red arrows approximately correct, black arrows getting larger. Initial velocity vector in blue is larger than red arrows.

# Colored Masking Tape



# Colored Masking Tape



Give students vectors **A**, **B**, have them find **C**:

$$\mathbf{C} = \mathbf{A} + \mathbf{B}$$

**Example: A = 45 cm East, B = 30 cm North**

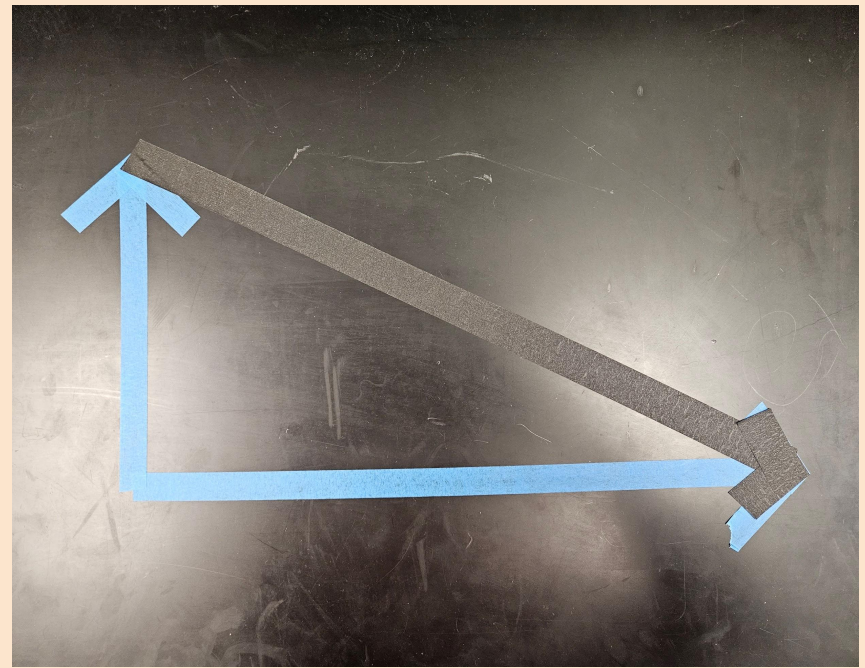
Usually tell students to use the edges the lab table/counters as perpendicular.

Measure vector lengths from the center of the width of the tape.

Good idea to have the students label all vectors by writing on tape.

# Colored Masking Tape

Students can still make the usual mistakes, not adding vectors “tip to tail”.



Benefits: practice measuring with meter stick and protractor, errors and error propagation (exactly how long is your tape, and if an angle is wrong, how does that change your final vector?), “hands on”



# Pythagorean Triples of pre-cut line.



Benefits: Go outside. Practice measuring lengths, angles on a larger scale. Ask students in a 3-4-5 triangle if the angles **MUST** be correct if the lengths are correct, watch them think.

# Pythagorean Triples of pre-cut line.

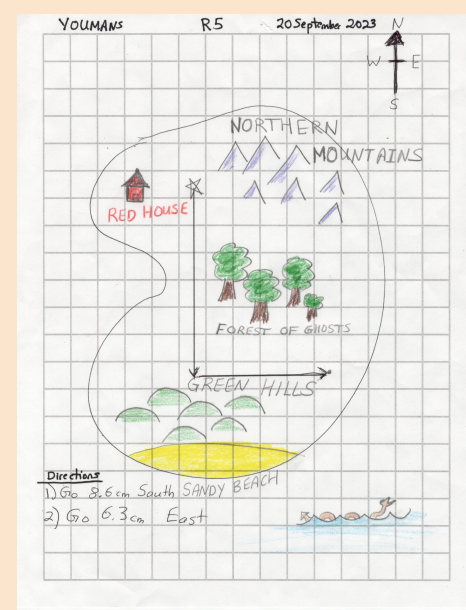


Problems: Go outside (time), injuries and damage to tape measures. Avoid string, use heavier line. Pre-cut lengths of rope seem best/most efficient.



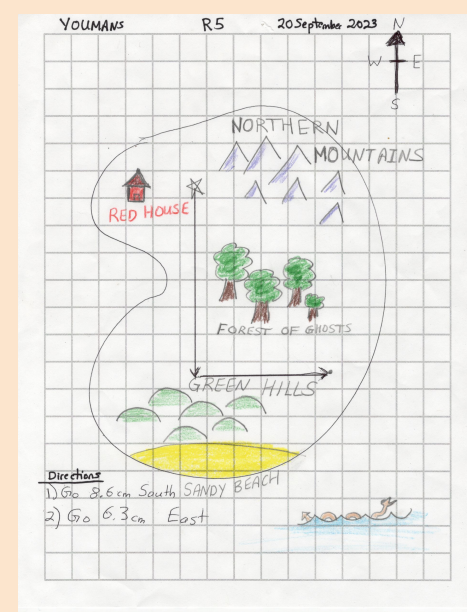
# Pirate Treasure Maps

- 1) cardinal directions, (x,y) grid,
- 2) choosing origin  
(The origin is choice that the student makes, not a “given”).
- 3) writing directions teaches “tip-to-tail”,
- 4) makes explicit the importance of the length of the vector,
- 5) encourages imagination (artsy stuff) as well as careful measurement, teaches that creativity can be enhanced by careful measurement, and vice versa.



# Pirate Treasure Maps

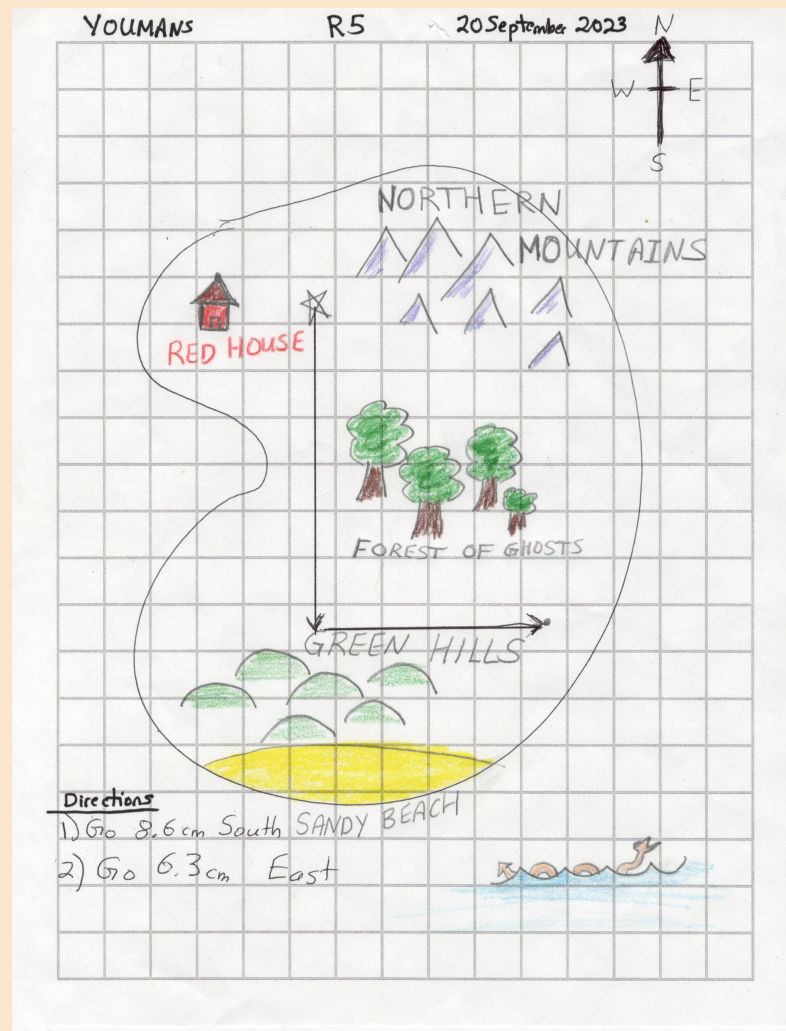
Give students an example, and let them work for 15-30 minutes, then have students present their map to the class.



# Example

(given by teacher to the class)

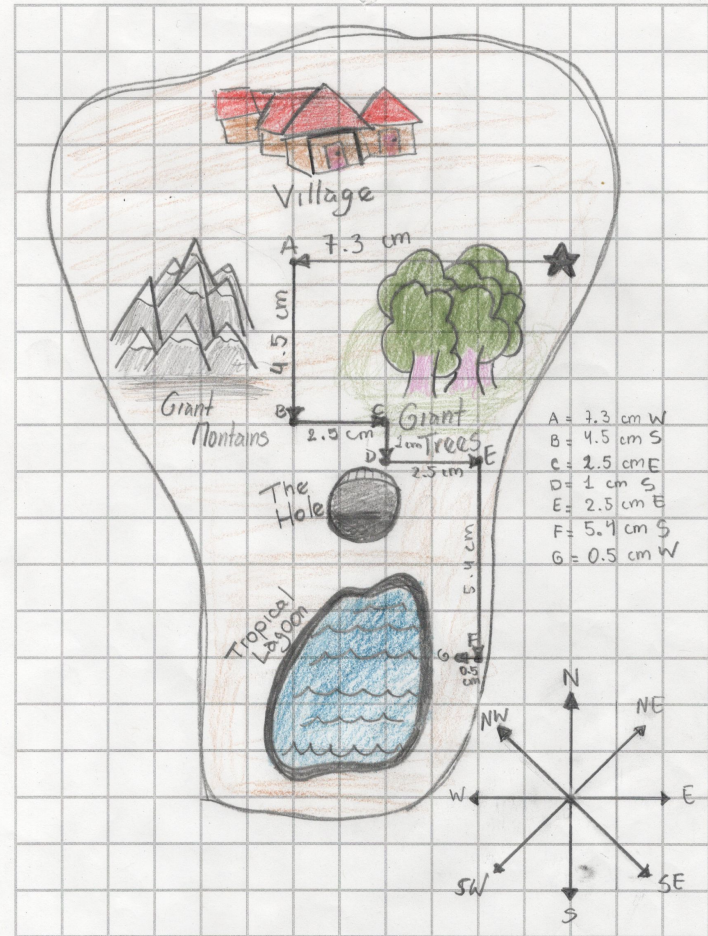
Experience shows that simple vectors work best as an example, students will naturally try more vectors, differing angles.



# Example (student)

## Precision/Accuracy:

Example of measuring lengths to the nearest mm correctly.



# Example (student)

## Nice and Easy

Simple work, receiving full points. Slight error, did not start from the center of a star.

W6 21 september 2023

MAP 10  
Rose 10  
Directions 10

30  
30

Directions

- ① Go 1.5cm W ✓
- ② Go 7.5cm S ✓
- ③ Go 2.5 E ✓

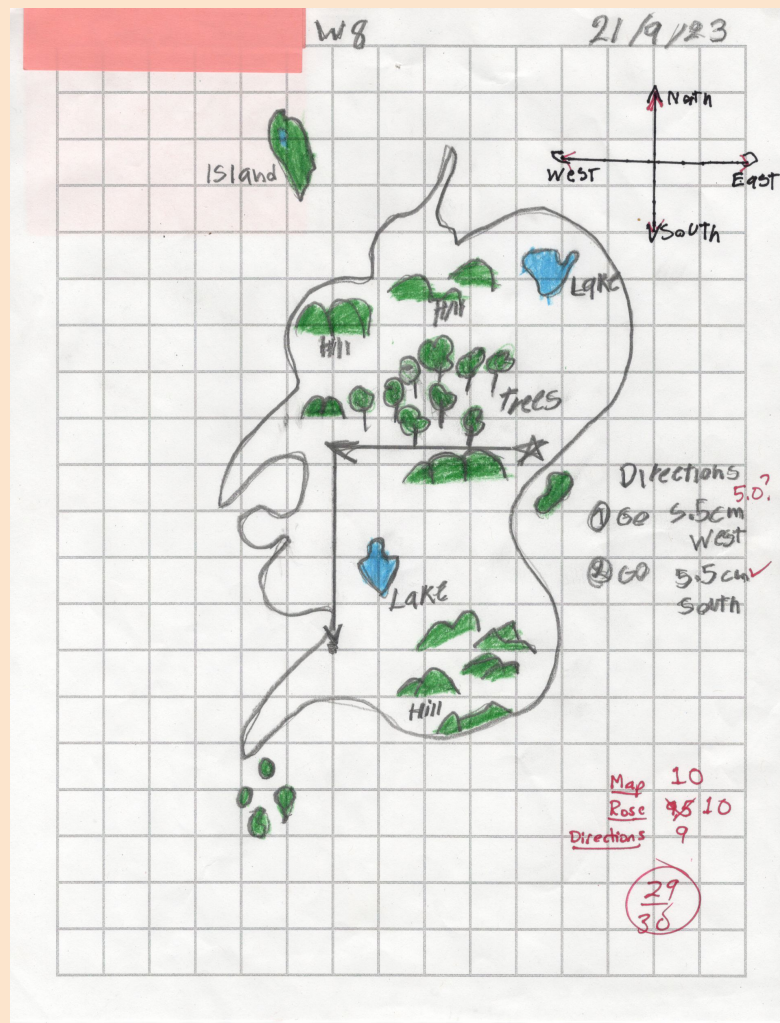
The map is drawn on a grid. A star is at the center of a 3x3 grid. An arrow points west from the star to a house. From the house, an arrow points south to a cow. From the cow, an arrow points south to a tree. From the tree, an arrow points east to a dinosaur. A compass rose is in the top right corner, with N at the top, S at the bottom, W on the left, and E on the right. The path is marked with arrows and a star at the starting point.



# Example (student)

## Engagement:

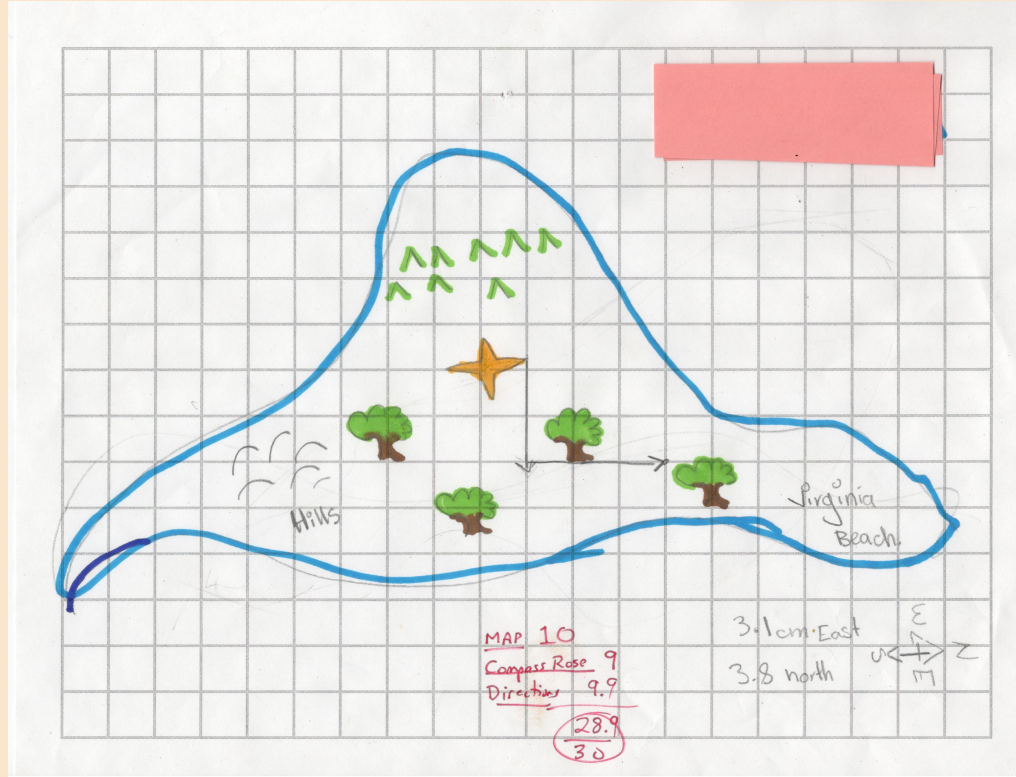
This student usually sleeps entire class, or on cell phone, or does not attend: the first time that I've seen student use a ruler voluntarily.



# Example (student)

## Originality and Accessibility

Level 1 English Learner: student's first day in school, has been in the USA ~1 week.

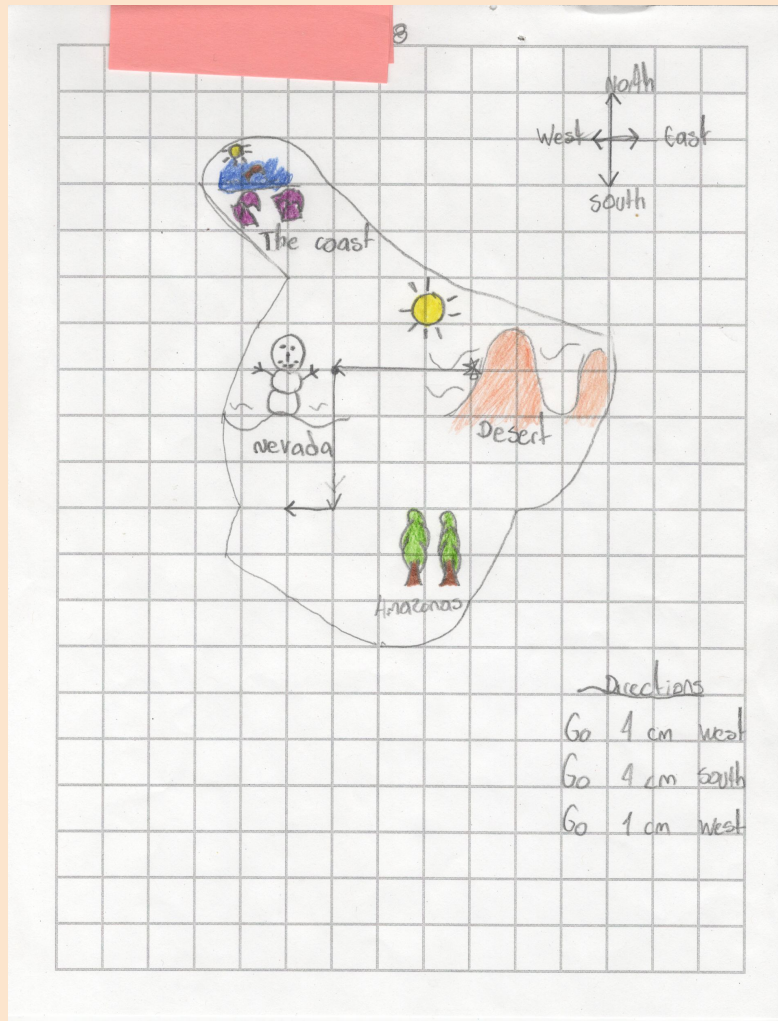


# Example (student)

## Humor, Joy:

Level 1 English Learner,  
been in American High  
School for 1 month.

(The student knows that  
Nevada is a desert and the  
it snows in the mountains.)



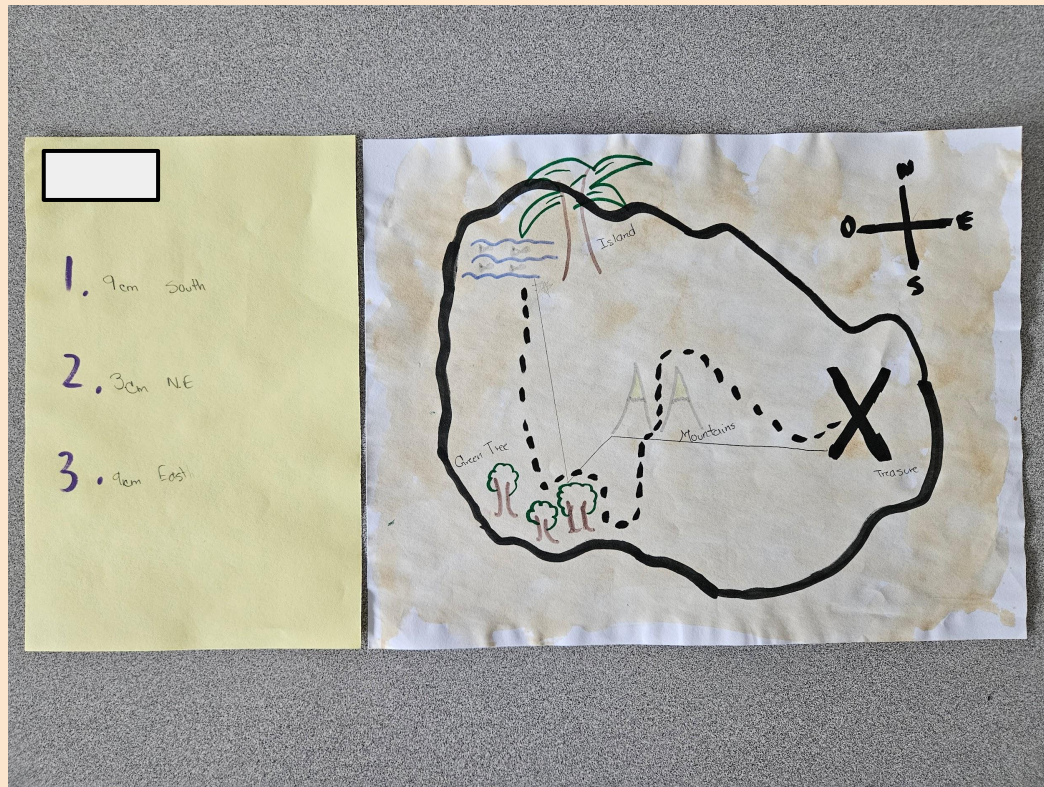


# Example

(student work by another teacher)

## Individuality:

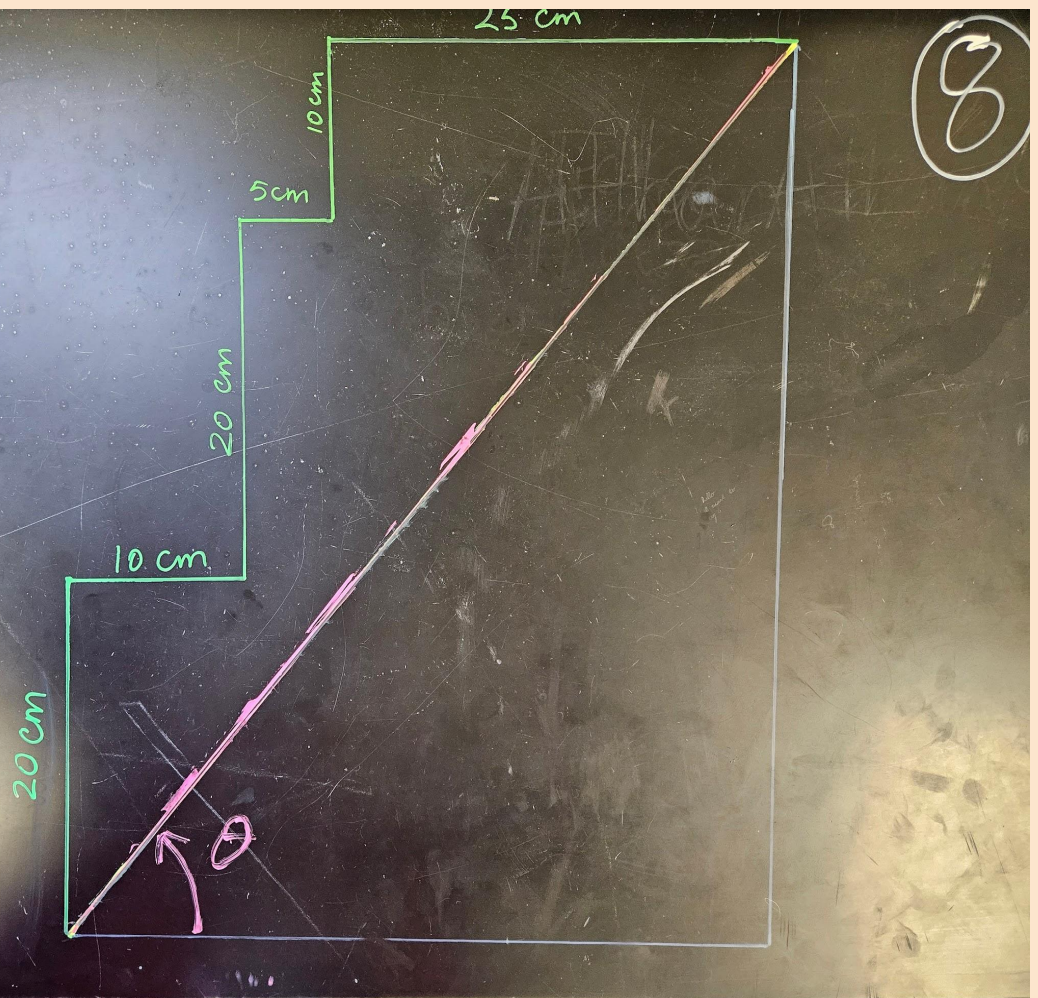
This teacher used tea bags to dye the paper. Teaching a class of level 1 English Learners, this teacher thought this activity was very good.



# Drawing Vectors

Another HS Teacher  
(10+ years experience)  
Doesn't want to do pirate maps  
Has 8 stations around the room  
to find the pink resultant.

Usually focuses on just adding  
(vertical, horizontal)  
components and using tangent  
to find the angle.





Turn a “bleh” math activity into a hands-on activity by:

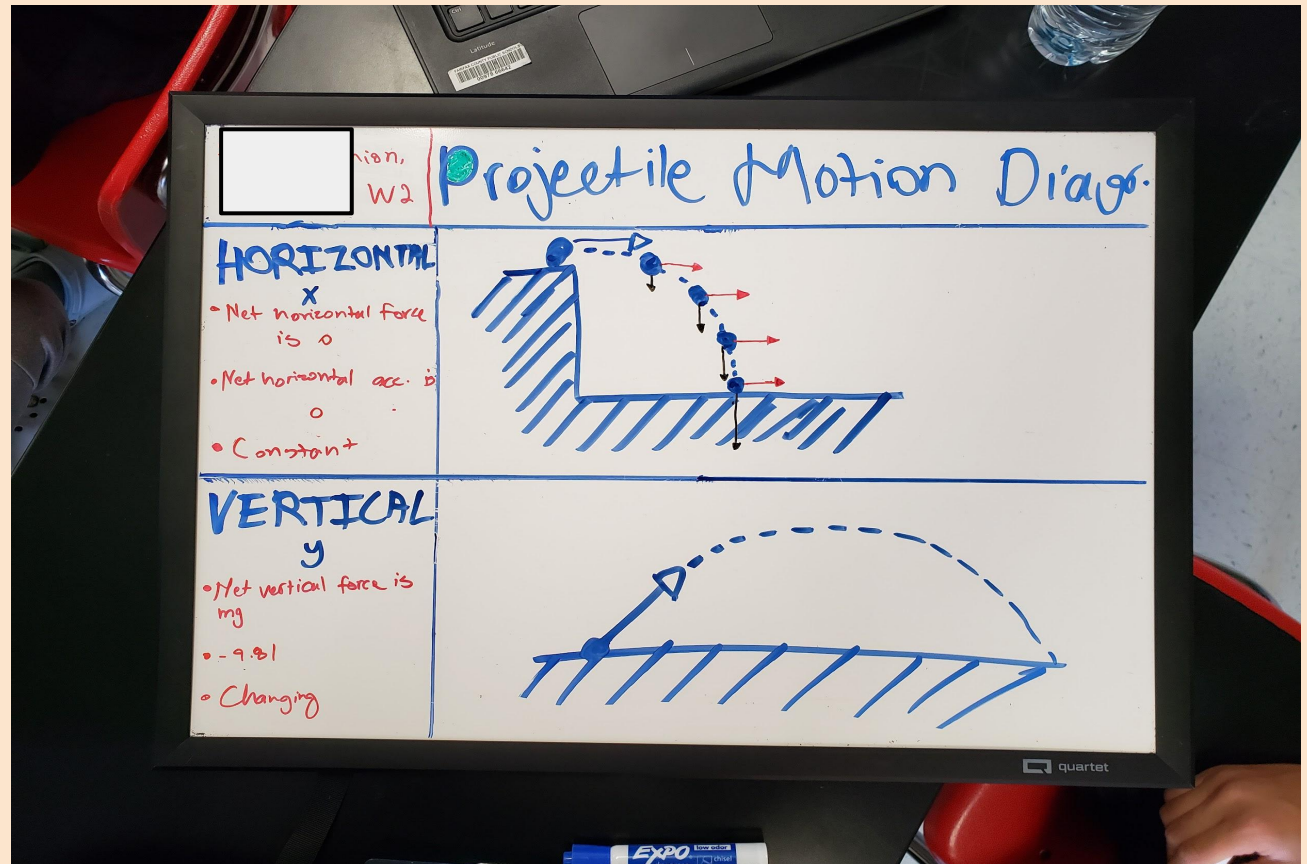
- a) making it larger,
- b) different materials,
- c) explicitly rewarding “artsy” stuff, creativity,
- d) making students move and measure,
- e) generalizing coordinate systems: origin, scale, units, cartesian/polar

~~Goal~~ Achievement: Students show more “mastery” throughout the school year.

# “Mastery”

Independent student work  
~1-2 months after masking  
tape vector addition and  
drawing colored vectors in  
front of the class.

Students had received a  
10-15 minute lecture on  
projectile motion, and the  
next class session (about  
2 days later), they had a  
question sheet, they  
worked in groups to  
answer the questions on  
the small whiteboard.



# References and Acknowledgements:

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