Summary of Summer Activities:

The initial week was spent reviewing the literature on computational thinking and the need for it. Our task was to create Scratch projects to use in middle school STEM classes. Scratch is a web-based platform that introduces computer programming with visual blocks. Stacking puzzle-shaped blocks of code instead of learning the syntax of a particular language allows one to acquire computational thinking skills. Those analytical skills and a logical thought process are applicable to many fields.

Another component of our summer’s work was to observe and evaluate a Region 12 training.

Scratch Learning Experience

The only computer programming experience I had was a one-semester course in BASIC my freshman year of high school many years ago. I expect that my learning experience would be similar to other inexperienced programmers that teach science.

My original approach was to jump in and try some things. When that was unfruitful, I did the short “make me dance” tutorial found on the HELP page. I didn’t even follow the steps exactly, I modified things and added things as I explored. While I was able to add sprites and make them move where I wanted, that did not seem like real programming. Even before I knew more about Scratch, I thought that simple motion without variations, sensing, or operations was enough “programming” to be worth while.

To get to the next level, I began reading the ebook Learn to Program in Scratch by Majed Marji. I read and tried all of the activities in just chapters 1 and 2. Creating the script for a game of pong following the instructions in the book required forty minutes. After chapter 2 I felt comfortable enough to start my own original project. As I hit roadblocks, I consulted later chapters in the book, used the online help menu in Scratch and the wiki http://wiki.scratch.mit.edu.
Building scripts using sprites from the library was quite attainable. However, the sprite library did not include any science related graphics. Anything for science would need to be drawn or imported. Having no experience with any graphic art programs, this became a challenge. I didn’t understand the built-in drawing tools or have the artistic skill to make anything. Unable to make identical boxes in with Scratch tools, I used PowerPoint to group boxes with text and save the object as a picture. That picture imported nicely into scratch as a jpeg. I made a title frame for a backdrop in PowerPoint, but never could import it into scratch without pixilation.

**Scratch Project**

Core teachers are already very busy covering standards for the required state exams. Adding content that is untested and normally reserved for elective classes would not be embraced by many. To appeal to teachers, it must reinforce a topic that is prominent on the exam and be easy to implement. I believe I have designed a tool that meets both requirements. My Scratch lessons are based on Newton’s 2\(^{nd}\) Law. It is one of only 4 equations on the reference sheet and the 2013 STAAR exam included 3 items that required its use. My lessons are also ready to use. The student hand outs are self explanatory. A teacher need only preview the lessons (along side an answer key) and make copies for their students. My program uses an inquiry approach to discovering both the F=ma relationship and the features of Scratch. My Scratch project is simple enough to understand while incorporating all types of scripts (programming block types) except the pen. Ideally the student interest level and ease of implementation would whet a teacher’s appetite to explore Scratch more and design their own lessons.
Lesson #1 - Newton’s 2nd Law Guided Inquiry

Go to: https://scratch.mit.edu/projects/69717110

Review:

A **quantity** is the property that is being measured.
A **unit** is the unit of measure, the specified size of the pieces used to describe the quantity.

1. Circle the units and put a box around the quantities:
   - distance
   - second
   - centimeter
   - pound
   - weight
   - time
   - inch

Explore:

2. Which box has a mass of 40? small medium large
3. Which box has a mass of 60? small medium large
4. What is the unit to measure mass in this activity?
5. Are the 3 boxes made of the same material? How do you know?
6. What quantity is effected when you change the strength of the guy? 7. What is the unit to measure that quantity?

Record:

8. Complete the table for every possible combination of guys pushing boxes:

<table>
<thead>
<tr>
<th>BOX</th>
<th>GUY</th>
<th>FORCE (N)</th>
<th>MASS (kg)</th>
<th>ACCELERATION (m/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

You must “push it” to get the reading for acceleration.

Explain:

9. Look at the 3 rows in your table for the small box. What happens to the ACCELERATION when the FORCE is increased?
   - it increases (directly related)  it decreases (inversely related)
10. Look at the 3 rows in your table for the weak guy. What happens to the ACCELERATION when the MASS is increased?
    - it increases (directly related)  it decreases (inversely related)

11. Write an equation that includes force (F), mass (m), and acceleration (a).
Lesson #2 – Newton’s 2nd Law – Discover SCRATCH Basics

Go to:  https://scratch.mit.edu/projects/69717110   Click to

Explore:
1. How many “sprites” are used in this project?
2. In your own words, what is a sprite?
3. How can you show weak, regular, and strong guys if there is only 1 guy sprite??

Look at the “scripts” for each sprite.ScriptsCostumesSounds
That is the coding that tells the sprite what to do. All sprites have this script
4. What does this tell the sprite to do?  HINT: Click the green flag and see what
happens the first 3 seconds

The backdrop for SCRATCH has an x-axis and y-axis with the origin in the center like this:
5. Exactly what is the starting position of the guy?  6. Of the box?

7. How do you know??

8. Look in the scripts. Which sprite broadcasts “message 3”?

9. What 5 things does the box sprite do when it receives “message 3”?

10. Match the line of script to the action:

A. Change the box to the darkest color

B. Make the gray box in upper right corner with kg, N, \& m/s²

C. Move box to the starting position

D. Show the quantity mass in the upper right corner

E. Change the value for mass to 60
Go to: https://scratch.mit.edu/projects/69717110

Explore:

Look at the different types of scripts.

1. What color are the SENSING scripts?

2. Which sprite uses a SENSING script?

3. What does the script sense??
   A. how fast the guy is traveling
   B. where the guy is located
   C. the costume of the guy

Look at the different types of scripts.

4. What color are OPERATORS?

5. Which sprites use an OPERATOR?

6. In the Push It Button sprite, how is ACCELERATION calculated?

Look at the different types of scripts.

7. What color are DATA scripts?

8. What 4 variables were created for this project?

Look at the box sprite:

9. The program doesn't know that “velocity” refers to how fast something moves, it just does what scripts tell it to do. How does this tell the box to get faster and faster?

10. This loop continues “forever”. Why does the box stop?
    HINT: Look at other sprites for a stop all script
Lesson #4 – Newton’s 2nd Law – Join SCRATCH & Modify the Script

Go to: https://scratch.mit.edu/projects/69717110

In the top right corner click to Join Scratch:

Your teacher might have guidelines for choosing a username & password.

Click Remix in the top right corner, so that you can modify the code.

Modify:

Modify the program so that the guy pushes the box across the middle of the screen instead of across the floor.

HINT: You can pick up the sprites and move them. If you click on the i in the corner of the sprite, it shows you information about its position.

1. Show what you changed to modify the scripts for the guy:

2. Show what you changed to modify the scripts for the box:
Lesson #5 – Newton's 2nd Law  Create a Scratch Project

Make your own Scratch project based on Newton's Second Law:  \( F = ma \)
It can but does not need to include motion.
You must include at least 2 sprites.
You can use these graphics (available from teacher) or make your own.

10 N  20 N  30 N  40 N

5 kg  10 kg  15 kg  20 kg

Ideas: Try the \texttt{when space key pressed} script from the \texttt{events} menu to change box and arrow costumes.

Try the \texttt{say Hello!} script in the \texttt{looks} menu to say the acceleration that was calculated.

Try the \texttt{play drum} \texttt{X} \texttt{for} \texttt{0.25 beats} script in the \texttt{sound} menu to play when a costume is changed or a sprite is clicked.

Use back drops to show definitions of mass and force.
Lesson #1 – Newton’s 2nd Law Guided Inquiry

Go to: https://scratch.mit.edu/projects/69717110

Review:
A quantity is the property that is being measured.
A unit is the unit of measure, the specified size of the pieces used to describe the quantity.

1. Circle the units ( ) and put a box around the quantities:
- distance
- second
- centimeter
- pound
- weight
- time
- inch

Explore:
2. Which box has a mass of 40? small medium large
3. Which box has a mass of 60? small medium large

4. What is the unit to measure mass in this activity? kilogram

5. Are the 3 boxes made of the same material? How do you know?
The boxes all have the same size, so they must be made of different materials to have different masses.

6. What quantity is affected when you change the strength of the guy? What is the unit to measure that quantity?

Record:
8. Complete the table for every possible combination of guys pushing boxes:

<table>
<thead>
<tr>
<th>BOX</th>
<th>GUY</th>
<th>FORCE (N)</th>
<th>MASS (kg)</th>
<th>ACCELERATION (m/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>W</td>
<td>60</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>S</td>
<td>R</td>
<td>90</td>
<td>20</td>
<td>4.5</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>120</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>M</td>
<td>W</td>
<td>60</td>
<td>40</td>
<td>1.5</td>
</tr>
<tr>
<td>M</td>
<td>R</td>
<td>90</td>
<td>40</td>
<td>2.25</td>
</tr>
<tr>
<td>M</td>
<td>S</td>
<td>120</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>L</td>
<td>W</td>
<td>60</td>
<td>60</td>
<td>1</td>
</tr>
<tr>
<td>L</td>
<td>R</td>
<td>90</td>
<td>60</td>
<td>1.5</td>
</tr>
<tr>
<td>L</td>
<td>S</td>
<td>120</td>
<td>60</td>
<td>2</td>
</tr>
</tbody>
</table>

Explain:
9. Look at the 3 rows in your table for the small box. What happens to the ACCELERATION when the FORCE is increased? it increases (directly related) it decreases (inversely related)
10. Look at the 3 rows in your table for the weak guy. What happens to the ACCELERATION when the MASS is increased? it increases (directly related) it decreases (inversely related)
11. Write an equation that includes force (F), mass (m), and acceleration (a). 

F = ma
Lesson #2 - Newton’s 2nd Law - Discover SCRATCH Basics

Go to: https://scratch.mit.edu/projects/69717110

Explore:

1. How many “sprites” are used in this project? 11

2. In your own words, what is a sprite? Answers will vary
   An object used in the program

3. How can you show weak, regular, and strong guys if there is only 1 guy sprite??
   The guy sprite has 3 different costumes

   Look at the “scripts” for each sprite. That is the coding that tells the sprite what to do. All sprites have this script.
   4. What does this tell the sprite to do? HINT: Click the green flag and see what happens the first 3 seconds

   All the sprites are not visible for 3 seconds while the title slide is shown

   The backdrop for SCRATCH has an x-axis and y-axis with the origin in the center like this:

   5. Exactly what is the starting position of the guy? 6. Of the box?
      Guy x: -164  Box x: -14
      y: -74  y: -69

   7. How do you know??
      You can see in the script that is the position each sprite goes to at the beginning.

   8. Look in the scripts. Which sprite broadcasts “message 3”?
      Large box

   9. What 5 things does the box sprite do when it receives “message 3”?

   10. Match the line of script to the action:
      A. Change the box to the darkest color
      B. Make the gray box in upper right corner with kg, N, & m/s²
      C. Move box to the starting position
      D. Show the quantity mass in the upper right corner
      E. Change the value for mass to 60
Lesson #3 – Newton's 2$^{\text{nd}}$ Law – Discover more SCRATCH Basics

Go to: https://scratch.mit.edu/projects/69717110

Explore:

1. What color are the SENSING scripts? Light blue

2. Which sprite uses a SENSING script? guy

3. What does the script sense??
   - A. how fast the guy is traveling
   - B. where the guy is located
   - C. the costume of the guy

4. What color are OPERATORS? Light green

5. Which sprites use an OPERATOR? Guy, box, and Push It button

6. In the Push It Button sprite, how is ACCELERATION calculated? Force / mass

7. What color are DATA scripts? orange

8. What 4 variables were created for this project? Acceleration, force, mass, & velocity

9. The program doesn't know that “velocity” refers to how fast something moves, it just does what scripts tell it to do. How does this tell the box to get faster and faster?
   - Each time through the loop, the velocity increases
   - NOTE: the “80” is just a conversion factor to scale the appearance of the motion, so it stays on screen longer

10. This loop continues “forever”. Why does the box stop?
    - HINT: Look at other sprites for a stop all script
    - When the guy reaches a certain position, Everything stops.
Lesson #4 - Newton's 2nd Law - Join SCRATCH & Modify the Script

Go to: https://scratch.mit.edu/projects/69717110  Click to Join Scratch

In the top right corner click to Join Scratch:  

Your teacher might have guidelines for choosing a username & password.

Click Remix in the top right corner, so that you can modify the code.

Modify: Modify the program so that the guy pushes the box across the middle of the screen instead of across the floor.

HINT: You can pick up the sprites and move them. If you click on the i in the corner of the sprite, it shows you information about its position.

1. Show what you changed to modify the scripts for the guy:

```
when clicked
  hide
  hide variable force
  go to x: -156 y: -18
  wait 3 secs
  show
  when I receive message:
    set force x: to 0
    switch costume to costume1
    show variable force
  set force x: to 0
  when I receive message:
    go to x: -156 y: 120
    switch costume to costume2
    show variable force
    set force x: to 120
  when I receive message:
    go to x: -156 y: 120
    switch costume to costume3
    show variable force
    set force x: to 120
  when I receive message:
    go to x: -156 y: 120
    switch costume to costume4
    show variable force
    set force x: to -120
  when I receive message:
    go to x: -156 y: 120
    switch costume to costume5
    show variable force
    set force x: to 0
  switch backdrop to ground
  show
```

These should be changed to something between 20 & -10

2. Show what you changed to modify the scripts for the box:

```
when clicked
  hide
  hide variable mass
  wait 3 secs
  go to x: 20 y: 40
  show
  when I receive message:
    set mass to 20
    switch costume to costume2
    switch backdrop to ground
    show variable mass
  set mass to 40
  when I receive message:
    set mass to 20
    switch costume to costume3
    show variable mass
    set mass to 40
  when I receive message:
    set mass to 20
    switch costume to costume4
    show variable mass
    set mass to 40
  when I receive message:
    set mass to 20
    switch costume to costume5
    show variable mass
    set mass to 40
```

These should be changed to something between 10 & -10
Observations of Region 12 Training


8 participants at start – 5F + 3M …….. With late arrivials: 11 participants → 7F + 4M

9:04 - Background – The BRIC, seat & people tracking
About PBL Research and How to be a part

9:15 - Signals to get attention
Suggested Edutopia resource for signals
*Participants were asked what they use.*
*Observer, Mark, was first to volunteer answer, followed by others*

9:30 - Get Signed in to laptops and on to network
Research Question: What is the country that contributes the most to climate change?
Those that didn’t do survey do survey while others start research & report out on wall
Groups were determine by colored dots

*Some finished & talked before others*

10:18 - Listed outline for the First 5 days:
Day 1 – Creative problem
Day 2 – Eli Pariser Effect
Day 3 – Challenge Status Quo
Day 4 – Product & Communication
Day 5 – Go Global

*I endured 3 bouts of this training and I’m not sure what all of these mean & how to translate in into a class period that would set the tone I want for the year.*

Beacon Moment Video clip – Brent Smith – a decision, experience, or choice that shapes the outcome of your life

10:32 - Discussion after video
Wrote beacon moments that related to teaching & shared in groups

Groups we determined colored notecards

New groups formed (one of each color dot) to list the steps needed to solve a problem or answer a question

*This would have been better immediately after the opening activity.*
*It wasn’t until the 2nd time through this that I realized the 2 were related
And one of the other days groups did not generate the list, but were just referred to a list on the board from the day before.*

11:04 - Groups sorted cards into 2 categories – PROBLEM Based & PROJECT Based

One participant sorted cards into correct piles, but had the headings switched – showing that half way through the training, participants still weren’t sure what PBL even was.

11:29 - Hattie Ranking of things that impact student achievement
- shown, but not discussed

1:05 - Only 7 of 11 back from lunch when she started.  
This seems ridiculous for a 1.5 hour lunch break. A better communication of expectations & logistics might have helped. They do trainings there often, they should have a hand out of directions to appropriate lunch spots.

Given a scenario, plan an approach to solving problem (not solve the problem)

1:23 - Started talking about Day 2 although it was still very unclear just what to do Day 1! How to be Taught vs How to Learn

Steve Jobs video clip

1:36 - Eli Pariser TED Talk Personalized Google Search on Facebook

All participants engaged --- this may have been the only real take away from the training

2:15 - Google Operators.
A participant had a question about something in the slide – Judy said she would email something later.

2:38 - Discussion of what you expect from your students in terms of Effort, Products, & Communication

Listed “Facilitation Principles”

2:58 - Today’s teacher needs to create an environment in which students learn best ---- more important than teacher knowledge

THIS seems to explain this training. There was no real content or teaching, it seemed to be more about the nice chairs & regrouping of students. This was not at all what an Experienced teacher needed to start PBL.

3:05 - 20 minute research how to GO GLOBAL checking in after 10 min

* There is really not anything immediately useful to take-away. Can’t do anything the “First 5 Days” without a lot of additional prep. This would have been better billed as an “Intro to PBL”.... To recruit teachers for the research program to be trained. I don’t feel that anyone was trained in anything yet.

* There was no advantage to having separate disciplines different days. The research questions were slightly tweaked to different subjects, but still very general and there was no time to discuss anything content specific. All 3 of these trainings should have been 1 day. All groups were too small to even model the regrouping of students. One group of 23 students would have worked well.

* There was no hand out. Even if the PowerPoint is made available – there was little information in it. If the plan is to be “paperless”, then you need a website with information all in one place --- not a series of email attachments and links.

* Presenter had good techniques, but little valuable content for an experienced teacher.
Acknowledgements

A huge thank-you to Dr. Truell Hyde, Jorge Carmona Reyes, Dr. Li Wang, Dr. Lorin Matthews, and Gary Stark.

This work was supported by NSF grant No. 1262031

About the author

Lisa M. Tarman received the B.A. degree in physics from Lycoming College, Williamsport, PA in 1990, a M.A. degree in curriculum and instruction from Gratz College, Melrose Park, PA in 2002, and a M.A. degree in Physics from University of Virginia, Charlottesville, VA in 2008.

From 1993 to 1995 she taught physics, earth science, physical science, and applied science at Shenandoah Valley Jr Sr High, Shenandoah, PA. From 1995 to present she teaches physics and serves in school leadership at William Penn Sr High York, PA.

Mrs. Tarman is a member of the American Association of Physics Teachers, the National Science Teachers Association, and the National Council of Teachers of Mathematics. She has spent five summers in Research Experiences for Teachers (RET), two summers in the Academy Creating Teacher Scientists (ACTS), and one sabbatical semester in Penn State’s Research Experience for Urban Science Teachers.