**Boyne Tech Outline – Hacking Physics into Math Speaker notes:**

50 minute session

Outline number indicates slide number

1. **Intro Physics Video Tracker**: <https://www.cabrillo.edu/~dbrown/tracker/>
   1. http://goo.gl/wJG1Ae
   2. Have participants download.
   3. May have issues with Java on a mac.
   4. While participants are downloading and installing go through stuff we did in Physics and Math
   5. If there is time at the end I’d like to show you Vernier Video Physics and Vernier Graphical Analysis as well.
2. **Intro to my classroom**:
   1. NMCS Math Trailer: <http://youtu.be/Z6-mBAVPrIc>
3. **Connections between the Physics curriculum and the Math curriculum**
   1. 1st semester Physics is Newtonian physics.
   2. Entry points for middle school and high school math:
      1. Linearity
         1. Finding the speed of a car using radar like Police
            1. Add in fines for speeding and you get piece-wise linear
         2. Dominoes (also under Polynomials)
      2. Pythagorean Theorem
         1. Velocity vector addition (Pythagorean Theorem)
            1. Or Tension Vectors for that matter.
      3. Quadratic Equations
         1. Reaction Time Experiment (Physics)
         2. Fitting a Quadratic Model to Data
         3. Ball Drop – Physics (Motion and Inertia)
            1. Vernier video physics, Vernier graphical analysis
         4. Rolling a Can – CBR, Tracker
         5. Rolling a Car – CBR or Video Tracker
         6. M&M Catapults (projectile motion)
         7. Free Throw (projectile motion)
         8. Bulls-eye – Quadratics and Linearity (Projectile Motion)
      4. Wave motion and Trigonometry
         1. Hula Hoops
         2. Trig Transformations – Pendulums and Spring Weights
         3. Sound intensity (inverse square variation)
         4. Tone Recognition - Tuning forks and microphones
         5. Ask iOS Siri “plane overhead”.
      5. Polynomials and Rational Functions
         1. Conservation of momentum (i.e. collisions)
         2. Modeling the Law of the Lever
         3. Measuring Light intensity – inverse square variation
            1. LuxMeter app (free) and iOS device
         4. Combined Variation –
            1. Spaghetti Boards
         5. Tire Marks – Dan Meyer (Kinetic Energy)
         6. Domino speed based on space between the dominoes (physics)
         7. Terminal Velocity (Physics)
         8. Too Hot to Handle, Too Cold to Enjoy (Exponential Decay)
            1. Need temperature gauge
      6. Complex Numbers
         1. Impedence for AC circuits
            1. A+bi = resistance (real) + phase (imaginary)
4. **The equations used in Physics**
5. **Central Idea: if you can measure it, you can make a mathematical model for it.**
   1. Physics is the study of relationships in the physical world
   2. helps with finding the appropriate model
6. **Racing Day**
   1. Determining the speed of pull-back cars
      1. Great discussions on various representations of the data.
         1. How can you tell from the graph which car will win the race?
         2. What does the slope mean in this situation?
      2. Introduce the topic traffic tickets and the situation yields a 2nd day talking about piece-wise functions
7. **Racing Day pt 2**
   1. Determine the relationship between the pull-back distance and the total distance the car travels.
   2. Modeling
      1. Lines of best-fit and regression
8. **Domino Speed**
   1. How does the spacing between the dominoes affect the speed at which they fall down? Is there a ‘best’ spacing?
   2. Modeling
      1. Cubic functions
9. **Bulls Eye**
   1. Can we predict where an object will land as it rolls of a ledge?
   2. Vectors
   3. Quadratics
   4. Inertia
10. **Bulls Eye 2nd slide – using Physics Tracker to gather the data about velocity**
11. **Finding Momentum**
    1. By placing markers at set distances, we can then measure the velocity.
    2. This particular experiment was about what happens to the acceleration when we change the mass of the object being pulled.
12. **Rolling a Can**
    1. Video
13. **Rolling a Can 2nd Slide**
    1. Can set the distance of a known object
    2. Set a coordinate axis
    3. The data readout for the Tracker File
       1. Graph: (time, distance)
       2. Table: time, horizontal distance, vertical distance
14. **Trig Functions - Video**
    1. Setting a known distance and then gathering data based on the motion of the object
15. **Trig Functions Slide 2**
    1. Data can be copied and pasted into other applications
    2. This is a Geogebra workbook we used to create a function modeling the situation.
16. **You can do something similar on iOS**
    1. Vernier Video Phyics $5
    2. Vernier Graphical Analysis $5
    3. We’ll go through how these work at the end if there is time.
17. **Basketball Drop**
    1. This was my first 2nd attempt at something like this
       1. before I knew about Physics tracker
    2. Note to self: use a stand so the camera doesn’t move.
18. **Basketball Drop slide 2**
    1. Visual output for Vernier Video Physics
19. **Free throw**
    1. First attempt to use any sort of tracking software
    2. Used the data output in Algebra 2
20. **Free throw slide 2:**
    1. Slowed down the video in iMovie
21. **Measuring and Video Scrubbing**
    1. Vernier allows the video from the iPad to show both on the iPad and on the Apple TV at the same time.
    2. The time toolbar on Vernier Video Physics is much more exact than on the camera app.
22. **Physics Tracker Video Analysis and Modeling Tool – Your Turn!**
    1. Get video of an object in motion.
       1. Download one from the website
          1. Basketball drop from bleachers
             1. <http://youtu.be/VTRvNpY01FU>
          2. Mass cart moving 1 meter
             1. <http://youtu.be/c9UjpgnJ85M>
          3. Rolling a can up a ramp
             1. <http://youtu.be/xlJ43vofsII>
       2. Use a portable camera to take a video and then put it on your computer.
          1. NOTE: you want some way to measure distance in the video. Having a meter stick or another known distance somewhere on the screen is helpful.
23. **Open Tracker program**
    1. Click the open file button at the top of the screen.
       1. Navigate to your chosen video file.
       2. Click ‘open’
24. **Set the distance with the Calibration Stick**
    1. Click on the icon that looks like a line with plus signs on either end with a 10 next to it.
    2. Go to ‘New’ 🡪 ‘Calibration Stick’
    3. Grab the plus signs and pull them to either end of the known distance.
    4. Click on the 100.0 and change it to the known distance.
       1. If you don’t know the distance, leave it at 100.
25. **Create a Track**
    1. Go to the ‘Create option’
    2. I generally use ‘Point of Mass’
    3. Step the video forward to the place you want to begin measuring using the blue arrows at the bottom of the window and to the right of the video slider
    4. Place your cursor back over the video and press the ‘shift’ key. Your cursor should change shape to a square target.
    5. When you click on the object you would like to track, the video will step forward automatically by one frame.
    6. Finishing tracking the object.
26. **Place the Coordinate Axes.**
    1. Click on the ‘Coordinate Axes’ option (the two perpendicular pink lines)
    2. Drag the axes to where you would like them.
    3. Check out your video!
27. **Exporting to a standard video file.**
    1. File🡪Export🡪Video Clip
    2. The only setting worth changing is the ‘Format’.
       1. Choose your desired output – usually mpeg4
       2. Click ‘Save As’ and name your file.
28. **Pro Tip: Increase your Frames per Second**
    1. The camera app only record at 30 fps
       1. This isn’t near enough for objects moving at high speeds
    2. iPhone 5s will take faster video: 120 fps
    3. There are some apps which may help
       1. They haven’t helped my iPhone 4
29. **My thoughts on using tech:**
    1. In addition to the curriculum, I want to teach problem-solving, perseverance, collaboration, and curiosity.
    2. I use technology when I think it will help those things.
       1. Because incorporating technology always takes more prep time on my part. Always.
30. **Other uses I’ve found for 1 iPad and an Apple TV**
    1. Document Camera
       1. Evolution of the iPad stand
          1. Ring Stand
          2. D.I.Y PVC design
          3. Max Cases Handstand DX
       2. Class discussions surrounding student solution methods.
    2. Video of classroom
       1. Barbie Bungee – Algebra 1
       2. Hula Hoops Intro to Trig – Algebra 2
31. **Vernier Video Physics and Graphical Analysis** 
    1. Show video scrubbing using Barbie Bungee Instant Replay videos or/and F=ma Physics video
    2. Have person come and toss ball in the air.
    3. Use Vernier Physics app to create data for the Quadratic motion of the object.
       1. Take Video using iOS camera
       2. Add Video, set y/x axes, set measurement distance, add points to object.
       3. Open in Graphical Analysis
    4. Show Vernier Graphical Analysis as well.
       1. Top right wrench, choose 1 graph.
       2. Top left, choose which axis to show
       3. Bottom left gear, choose points.
       4. Top right wrench, choose table.
       5. Export table to Numbers (Open in)
    5. Show how to scrub videos for times using Vernier Video Physics.
32. **Website: www.andrewbusch.us**
33. **Questions**