



Study of Student Achievement

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Drexel University; School of Education, DragonsTeach Program

Table of Contents

Table of Contents2

Study of Student Achievement.....3

Focus4

Lessons Objective and Assessment (Rewrites).....8

Pre-Analysis11

Post-Analysis16

Conclusions & Discussion22

References24

Attachments.....25

Study of Student Achievement

This Study of Student achievement seeks to analyze the effectiveness of lessons taught to P. Isaac Quelly's 5th period class of 10th Grade General Physics at Central High School during the 2019-2020 school year.

Focus

The following is a description of P. Isaac Quelly's 5th Period General Physics class, data on the demographics at Central High School, and the focus of this study.

Class Demographics

The 5th Period General Physics Class contains 32 Students, of which, 4 have a 504 or IEP. All 504/IEP students have extended time on tests/exams for various reasons. However, it is my opinion (based solely on my interactions with them, as I am not permitted to see the documents themselves) that these accommodations are emotional/psychological in nature rather than because a specific learning disability (such as ADHD or Dysgraphia). In any case, the difference in performance that I observed from these students is based on time missed because of trips to counselors or because of testing anxiety. I do not see any ability difference otherwise.

Students in 5th period rely on a mix of learning modality, and do not seem to favor one over the other. If, however, I do not provide visual aids (pictures, gifs, graphs, demonstrations, etc.), most students indicate that they feel lost.

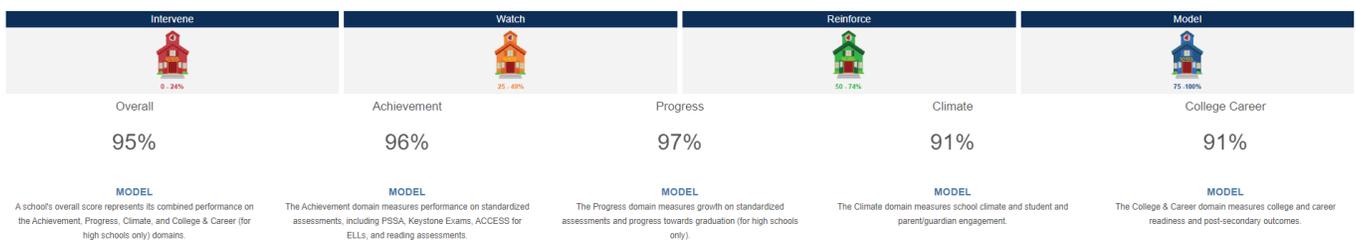
In terms of achievement, 5th period is a generally heterogeneous mix of students. There are AP and Honors level Physics available. However, I feel like many of the student that I would describe as being AP or Honors capable may not yet have developed their self-confidence to where they feel they would be successful in a higher-level course. Mr. Giacomini noted to me that their first marking period grades ($\bar{X}=85.1$) is higher than the past few years. We both believe that this is due to easier test questions and my willingness to award partial credit for correct work show. It should be noted, that CHS students ranked incredibly high for proficiency on keystones and 22nd in the nation for the School Performance Profile

(SPP) not yet released on the district data tool for current school year).¹ That said, proficiency on state tests (like algebra) are poor indicators for student’s proficiency in physics, as the student feel uncomfortable with transferring the skills to real-life scenarios.

Central High School Demographics

Demographic data is not parsed by classroom by any teacher-level report within the District’s gradebook software (Infinite Campus). Therefore, the following is information about the school population at large as of 11/27/19. Data and graphics acquired via PhilaSD.org. (Philadelphia School District, 2019)

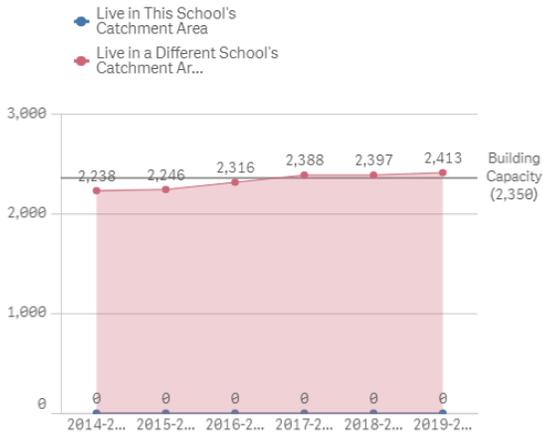
It should be noted that the demographic data for Central is based on internal Philadelphia School District Data. It is full of errors, especially in categories denoting race or ethnicity. This is likely due to the fact that the data is sometimes self-reported or is based off of a judgment call of a 3rd party (secretary or enrollment personnel) rather than the students’ family.



¹ At least as far as I can find. President McKenna relayed that information to us verbally last week.

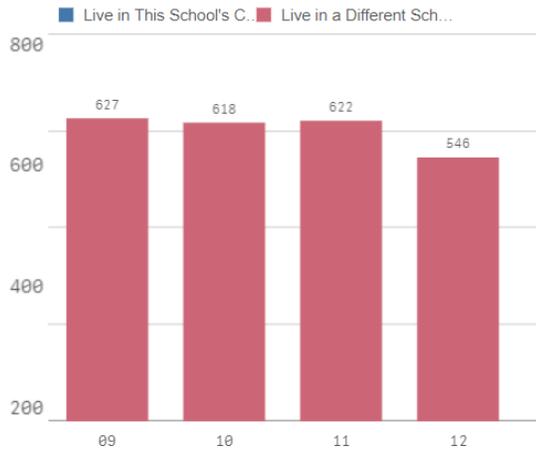
Enrollment by In/Out of Catchment (2014-15 to 2019-20)

16 difference in total students from October 1st 2018 to 2019. The current capacity for this building is 2350 students.



Enrollment by Grade Level

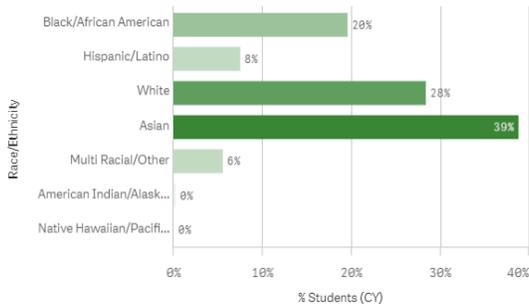
2,413 total students as of October 1st 2019-20 school year



57% ^{-5%} YOY Change

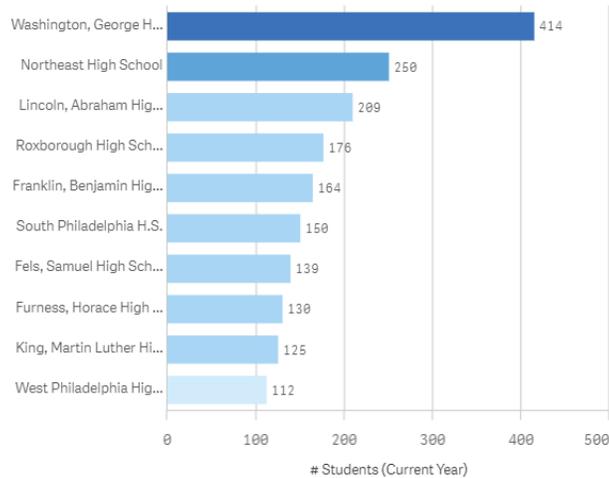
Students by Race/Ethnicity, Gender, and Age

2019-20



0.6% ^{-0.0%} YOY Change

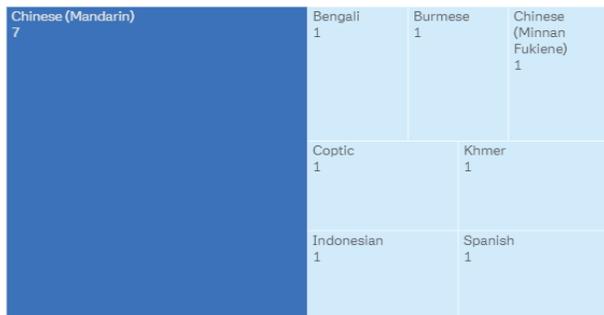
Top Neighborhoods Students in this School Come From (2019-20)



0.3% ^{-0.2%} YOY Change

Primary Home Language

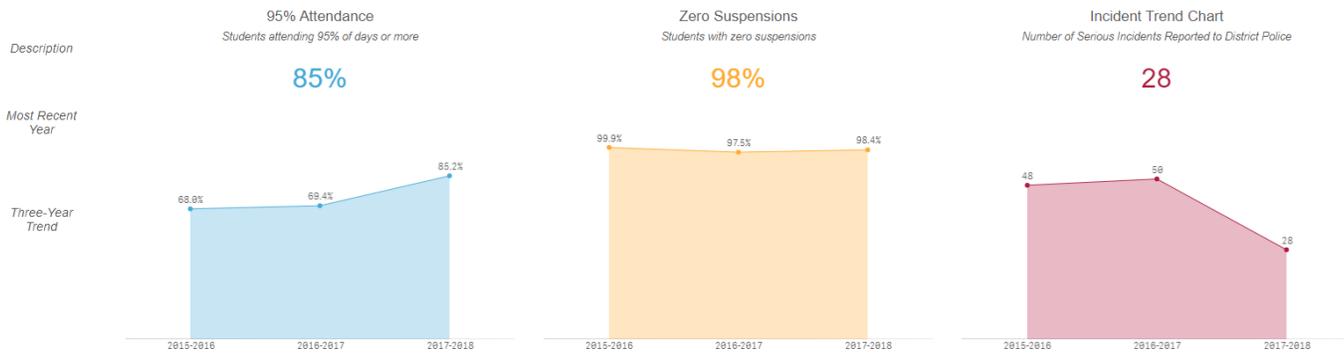
For EL students only (2019-20)



Primary Reason for IEP

2019-20





Study Focus

The goal of this study is to analyze their problem-solving skills via two indicators, how students represent vector quantities, and how students back up their reasoning with evidence and/or calculations. Physics is often thought of as an applied math course, and of those skillsets, vector math is a critical component of modeling the motion of objects. It then carries through to almost every other content touchstone. Along these same lines, Physics is a science based off of supporting one’s logic with evidence. Without evidence to back up experiments, conclusions, and opinions, the process evaporates. I seek to analyze both of these standards/skills as we progress though motion during November of my teaching.

I will assess students verbally, using exit tickets, printed warmup questions, smartboard apps, collected lab, and test #4. Because of the nature of the content, physics assessment in physics looks different than in most other content areas. Ideas that a delivered via direct instruction might be considered context rather than content. It is the enduring skills that are valuable moving forward. Therefore, not every day of the lesson does in fact have an assessment or even assessable goal. Entire class periods can be spent on a single practice problem, such as The Monkey Problem. The goals of such a class are not to recreate the solution to the problem, but to engage in discourse and apply to novel situations. This is why lesson plans can be copied and pasted for a week or more at a time. However, I have done my best to “rewrite” an addendum of sorts into this paper to clarify some of the lesson objectives so that they are transferable to others.

Lessons Objective and Assessment (Rewrites)²

2019.11.07 – Vector Addition Practice

- Objective: Students will know how to resolve and add vector components.
- Assessment: Practice problem exit ticket (could be collected as quiz³)

2019.11.08 – Vector Practice Lab

- Objective: Students will demonstrate how to resolve and add vector components (graphically and mathematically) and solve for magnitude & direction.
- Assessment: Vector Lab

2019.11.12 – Introduction to Projectile Motion

- Objective: Students will know how to define “projectile motion”, draw projectile motion paths, draw velocity vectors, resolve velocity vectors into components, and use graphic organizers to keep work neat.
- Assessment: Shout It Out about parabolic paths (Definition only).

2019.11.13 – Projectile Motion Practice

- Objective: Students will be able to draw projectile motion paths, draw velocity vectors, resolve velocity vectors into components, and use graphic organizers to solve application problems.
- Assessment: Shout It Out about freefall and projectile application, collected problem(s) on ½ worksheet.

² The lesson plans included as attachments were as delivered. Given that I have received additional feedback on how you would like goals/objectives and assessments, and that I already printed all of the lessons to PDF already, I've attempted to rewrite the lesson objective and clarify how I am assessing students within each lesson.

³ I'm not sure if I've ever made it clear or not, but my mentor teacher does not want me to give quizzes. Anything I collect as an exit ticket can't be graded. Therefore, it is harder to justify spending time creating the paper, passing it out, having them do the problem thoroughly, and collecting it again. It isn't as simple as walking around to look at the examples. A true problem takes 30+ seconds to evaluate for understanding.

2019.11.14 – Projectile Motion Practice

- Objective: Students will be able to draw projectile motion paths, draw velocity vectors, resolve velocity vectors into components, and use graphic organizers to solve application problems.
- Assessment: Collected problem(s) on $\frac{1}{2}$ worksheet.

2019.11.15 – Projectile Motion Practice (The Monkey Problem)

- Objective: Apply projectile motion concepts to conceptually solve the monkey problem while supporting conclusions and opinions with evidence.
- Assessment: Verbal, the discussion is the important part; Sticky note with what they want to cover during the review (assesses how well they can articulate concepts).

2019.11.18 – Test Review Day

- Objective: To review Vectors Addition and Projectile Motion
- Assessment: Verbal questions and responses.

2019.11.19 – Test #4

- Objective: To demonstrate knowledge of Vector Addition and Projectile Motion.
- Assessment: Test

2019.11.20 – Introduction to Forces

- Objective: Define “force”, categorize forces, understand that forces can be represented as vectors, and represent forces using a Free Body Diagram.
- Assessment: Shout It Out about Forces.

2019.11.21 – Introduction to Newton and N1 & N2

- Objective: Understand the implications of N1 & N2 and think of scenarios where they might apply.
- Assessment: Shout It Out listing examples of each.

2019.11.22 – N3 & Practice

- Understand the implications of N3 and think of scenarios where they might apply. If time, begin to solve practice problems quantifying N2.
- Assessment: Shout It Out listing examples of each, collected practice problem using N2.

Pre-Analysis

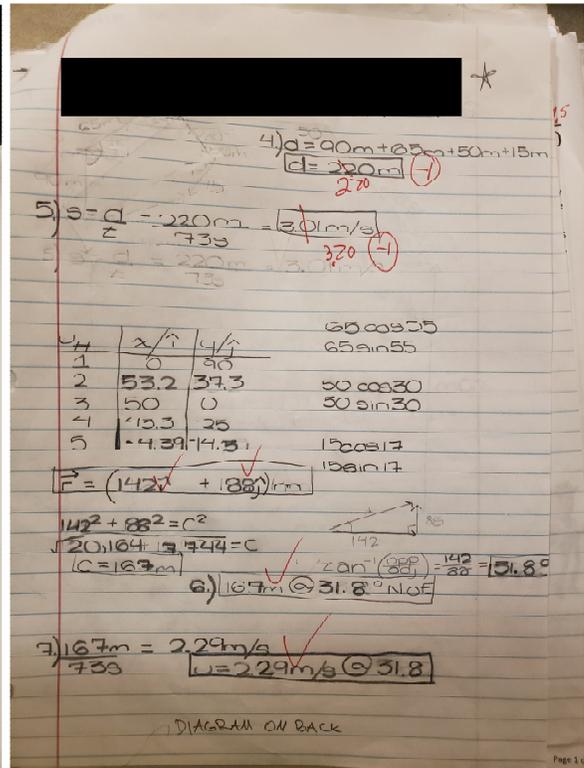
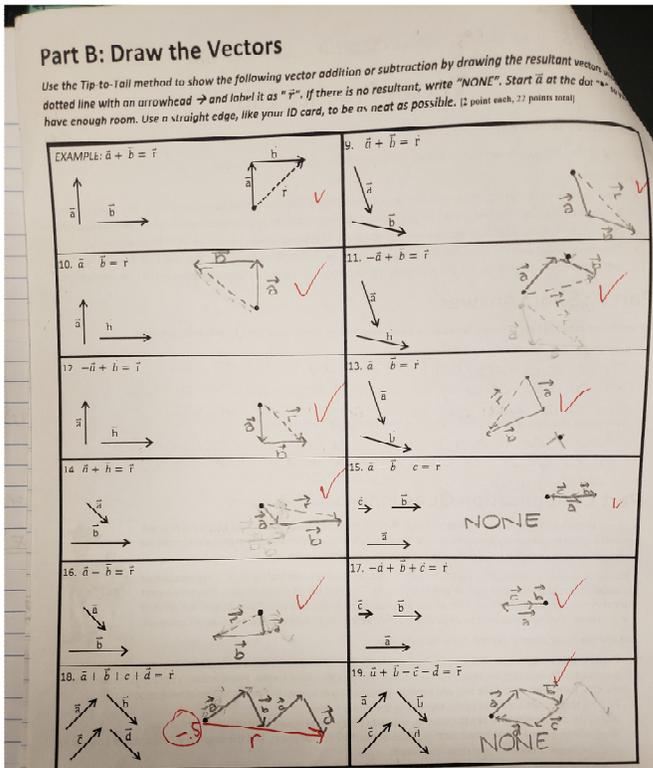
The following reflects lessons and an analyses of student work and observations from each day.

2019.11.07 – Vector Addition Practice

This lesson was moderately successful. All of the problems were done as a class. Students were able to answer questions, work in partners, and guide the class in solving the vector addition problems. While their pace was slow, their continued transfer of these same skills to Projectile Motion the following week would increase their confidence and speed. A common mistake continues to be an issue (so I'd been told, since I had not been teaching the preceding days) to be adding like terms in \hat{i} and \hat{j} .

2019.11.08 – Vector Practice Lab

This lab was very successful. It was given while both Giacomini and I were away at The Franklin Institute with his 25 12th grade Modern Physics Students. After grading the labs, most students got most of the vector addition questions correct. Common mistakes included: 1) not adding labels 2) not including resultant vectors 3) having vectors (including the resultant) the wrong direction 4) always starting at the origin rather than the tip of the preceding vector. Some of these mistakes [1) & 2)] can be seen in the included examples of student work. This group did show a great deal of calculations as evidence for the extended problem.



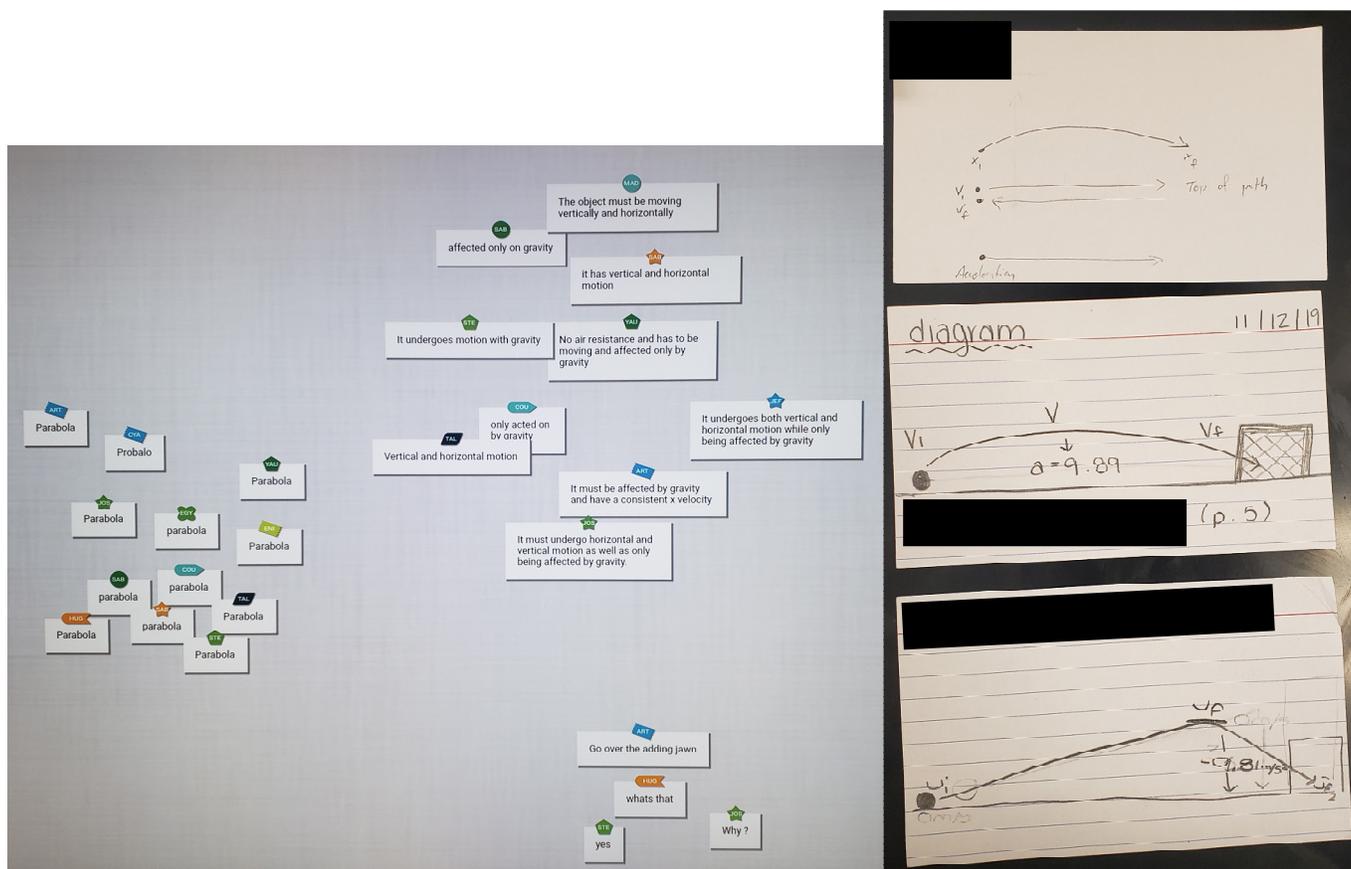
2019.11.12 – Introduction to Projectile Motion

This lesson was successful in terms of the amount of content covered. Turning in the Vector Lab assignment took a great deal longer than expected. I asked them to choose the best sheet to be graded for correctness and turn in the others with it for completion. This was a great idea in theory. I am trying to persuade them to not “divide and conquer” the problems by asking that they all turn in their labs to make sure they are doing the problems and contributing. When they do divide and conquer, they are not generating their own evidence of their conclusions, which defeats the purpose asking the group to work collaboratively. In future, I may be able to structure lab questions that require everyone to participate similar to how all group members were required to submit data for their high-jump or reaction time.

Students struggled to apply vector addition and resolution to physics. All of the problems were done as a class. Students had not yet memorized the requisite trig functions. This slowed them down considerably

when asked questions about which side trig function was used to find which side. Students also had trouble describing angle locations using cardinal directions. Students needed to be reminded multiple times which directions aligned with \hat{i} and \hat{j} directions. All of these skills would continue to be covered in the subsequent lessons.

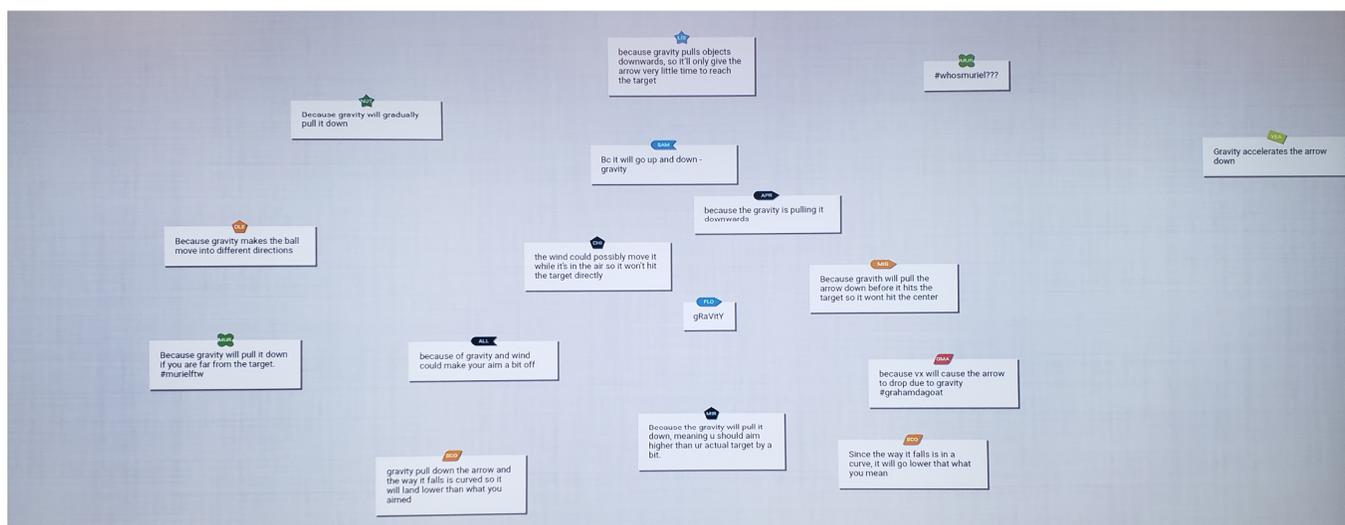
Included below are examples of student diagrams for the warmup question and a copy of the responses for the Shout It Out Question. Students can be seen incorrectly drawing the path of the object for the warmup, but then later correctly identifying that the shape of the path is parabolic.



2019.11.13 – Projectile Motion Practice

This lesson was more successful in terms of how the students progressed on being able to apply Vector Addition to Projectile motion practice problems. Students did not need to be reminded as frequently to use the graphic organizer. Some students were observed to be including it (the graphic organizer) in their notes without being prompted. Students still needed to be guided when understanding the problem statement

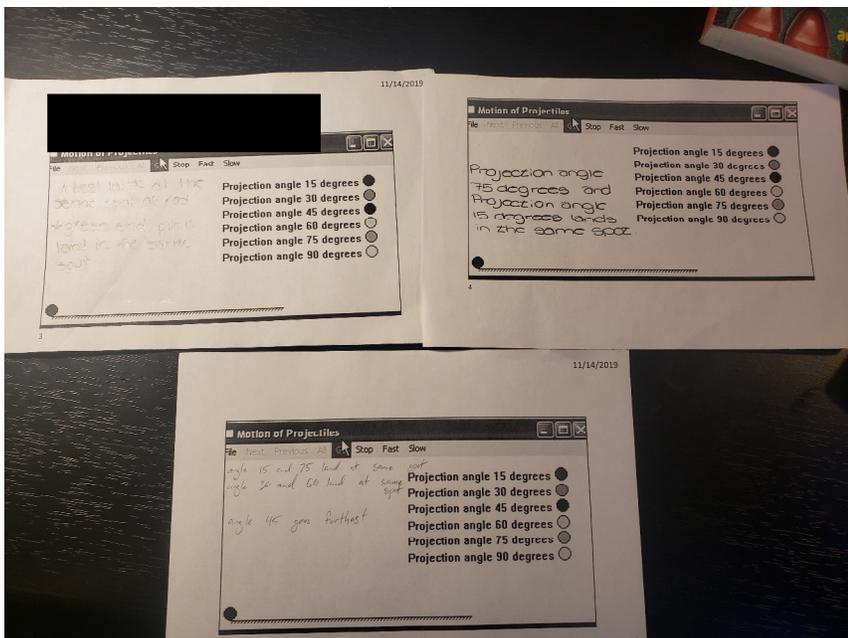
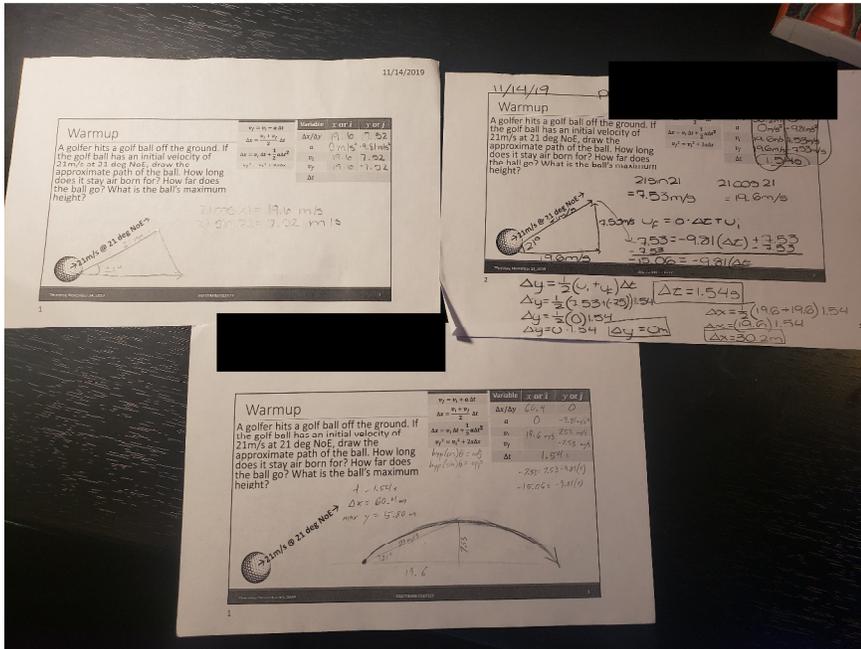
and drawing a diagram to represent the topic. Their use of the four kinematic equation was surprising effective considering they had not been used in a while covering vectors. Students started the period working on problems with an initial velocity only in \hat{i} , but shows enough proficiency to be introduced to a v_i in both \hat{i} and \hat{j} directions. Students were able to successfully answer the Shout It Out question about an arrow being shot at a target. The answers given were mostly thoughtful. However, there were some that were jokes and/or inappropriate. I had to remind the students that this was a learning tool for us, and that I would discontinue using it if they could not keep it professional. My hopes would be for this to be improved on simply because of the continued use. This lesson also made effective use of gifs. Students reacted positively to seeing the cannonball along the parabolic path with the changing velocity vectors.



2019.11.14 – Projectile Motion Practice

This lesson was also successful. Students were able to transfer their knowledge of projectile motion and vectors to more complex problems (initial velocity in y not equal to zero). Students seem to really grasp that they need to say within a specific dimension when using the kinematic equations. Most students were observed to be drawing some form of the graphic organizer in their notebooks as they solved problems.

As evident by the collected warmup question, students are still struggling to project draw diagrams of the problem situations while differentiating between drawing vectors (with angles, triangles, and straight lines) and paths of motion. However, they are doing an exceptional job about rewriting the kinematic equation (similar to how a geometry proof is stated) as the starting point and intention of their calculation. Without this, their reader (me) does not know which equation they might be trying to leverage.

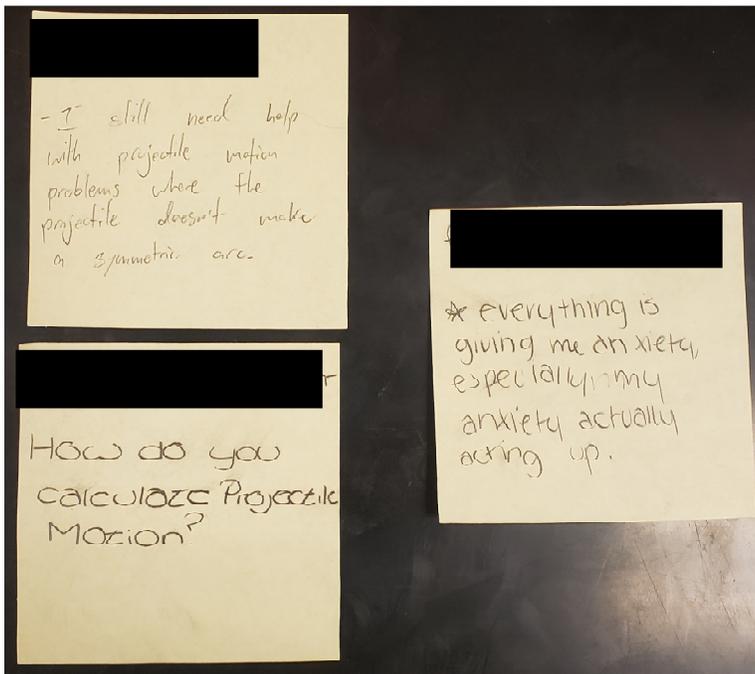


Post-Analysis

The following is an analysis of the effectiveness of the second set of lessons, as well as changes made because of the first set of lessons.

2019.11.15 – Projectile Motion Practice (The Monkey Problem)

In attempt to make their written evidence less verbose and more precise (in response to answers on the Vector Lab and their underdeveloped independent algebra skills (most students are currently in geometry) I would make a more intentional effort to include conceptual discussions and solutions to problems. Therefore, this lesson was changed to only solve the Monkey Problem conceptually and not algebraically. I could therefore focus more intently on drawing diagrams and discussion dialogue. In terms of assessment, I asked students to write down their number 1 stressor that they wanted to make sure that I covered during the review the next period. This has the added benefit of allowing for some self-reflection into their own ability, and perhaps prompt them to proactive this concept independently over the weekend before the test.



2019.11.18 – Test Review Day

The test review day focused on preparing for the exam the summative evaluation the following day. Already I think my discussion skills, simply improving over time, have started to shift the students back to always giving evidence alongside their conclusions. By almost always following their answers with some variation of “why”, I am getting the message across that I insist that follow up with their logic.

As evident by the change in handwriting, this homework problem was presented by a student. While this admittedly only evaluates this one specific student, I feel it gives insights into the students’ confidence in their own abilities. They often know the right answers, or at least a reasonable place to start. By continuing have conceptual conversations, they are building their persistence and trusting what they know. In some respects, “fake it until you make it” does allow students to stumble on the right answer. The more they try, and the more they succeed, the more they feel comfortable with feeling uncomfortable (not knowing the answer.)

1. In a scene in an action movie, a stuntman jumps from the top of one building to the top of another building 4.0 m away. After a running start, he leaps at a velocity of 5.0 m/s at an angle of 15° with respect to the flat roof. Will he make it to the other roof, which is 2.5 m shorter than the building he jumps from?



idk if this is right.

$$\Delta y = v_i t + \frac{1}{2} a t^2$$

$$= (1.29)(.828) + \frac{1}{2} (-9.81)(.828)^2$$

$$= -2.23 \text{ m}$$

$$.828 \text{ s} \leq t$$

Variable	x or \hat{i}	y or \hat{j}
$\Delta x / \Delta y$		
a	0	-9.81
v_i	4.83	1.29
v_f	4.83	
Δt		.828 s

Tuesday, December 3, 2019 GIACOMINI/QUE

2019.11.19 – Test #4

The test period was straightforward. It required little to know interventions by myself of Giacomini. There were a few numbering issues with the test. I did have to issue a correction to the cardinal direction on question #10, and question #11 should be 28.0 m/s. Even with Giacomini looking at the test and checking the calculations, errors slip though.

I am particularly proud of questions #8 and #9. Rather than asking them to do perform a vector addition problem or two, I asked them to correct someone else's work. This moves their thinking and my level of questioning even higher on Blooms Taxonomy, since I am asking them to Evaluate and Analyze.

As expected, many students did forget to put arrows on resultant vectors, or had the vectors pointed in the opposite direction. It was clear though, if a student had mastered the concept or not. If they didn't, they would write something like "they did not add the vectors correctly" or "they did not do the tip-to-tail method correct". The answer that I was looking for is what was the specific mistake they made as they were using the tip-to-tail method or doing the vector addition.

38.5
50

Fill in the Blanks
Complete each statement or sentence with the BEST answer. (3 points each, 9 points total)

- A physical quantity that has both magnitude and direction is known as a vector. A physical quantity that has magnitude, but no direction is known as a scalar.
- The tip-to-tail method is a way to graphically represent vector addition. You can then draw an arrow from the initial to the final to find the displacement.
- In order to add two or more vectors that are not completely along the i and j directions, you must first resolve a vector into its two component vectors. The i direction is along the x axis, and the j direction is along the y axis.

Short Answer
Remember: use a ruler!

- What does the commutative property let us do with vector addition? Show an example, either algebra or the tip-to-tail method. (2 points)
 $a+b=b+a$ or
 "any order, same result"
- Why should you not aim right at the center of a target? Look at the picture. If you are stuck? (2 points)
 Gravity causes things to fall towards the ground. If you aim directly at the center, the ball will fall before hitting the target. We compensate by aiming top left.
- If you want to throw/kick a ball the farthest you possibly can, but you can't change the speed/velocity that you throw/kick at, what is the ideal angle θ you should throw/kick at? Why? (2 points)
 45° because it is that will give the ball the perfect amount of air time.
 highest V_x & V_y combo

Helpful Physics Equations:
 $v_f = v_i + a \Delta t$
 $\Delta x = \frac{v_i + v_f}{2} \Delta t$
 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
 $v_f^2 = v_i^2 + 2a \Delta x$
 $\cos \theta$
 $\sin \theta$
 $\tan^{-1}(\frac{opp}{adj})$
 $c^2 = a^2 + b^2$

Fill in the Table

7. Look at the diagram below that shows a ball being kicked and landing 2.44m to the right after 0.815s. Notice/under the important information and fill in the table below. You don't need to do any calculations to find the values and units. (2 points)

Variable	x or i	y or j
$\Delta x / \Delta y$	2.44 m	0 m
a	0 m/s ²	-9.81 m/s ²
v_i	3 m/s	4 m/s
v_f	3 m/s	-4 m/s
Δt	0.815 s	0 s

Correct the Work
Look at the two vector addition problems below and help your friend correct their answers. For full credit circle the error, make a correction, and write a one sentence summary of why it was not correct/what they should have done.

8. $\vec{a} + \vec{b} - \vec{c}$ (3 points)

a) Friend's incorrect work...

b) What their work should have looked like...

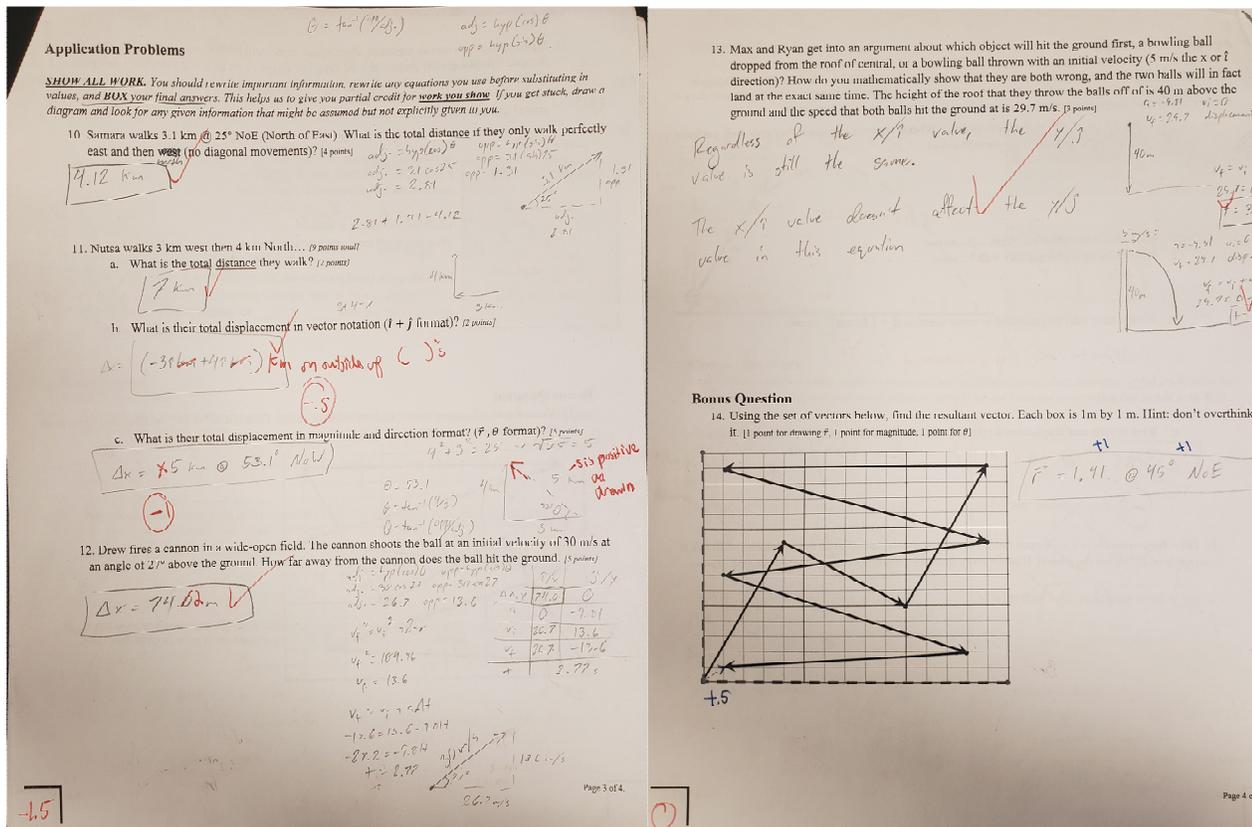
c) If was wrong because...
 When adding vectors with the tip to tail method, they should have started at the tip of \vec{a} , not the starting point.

9. $\vec{a} + \vec{b} + \vec{a} + \vec{b}$ (3 points)

a) Friends' incorrect work...

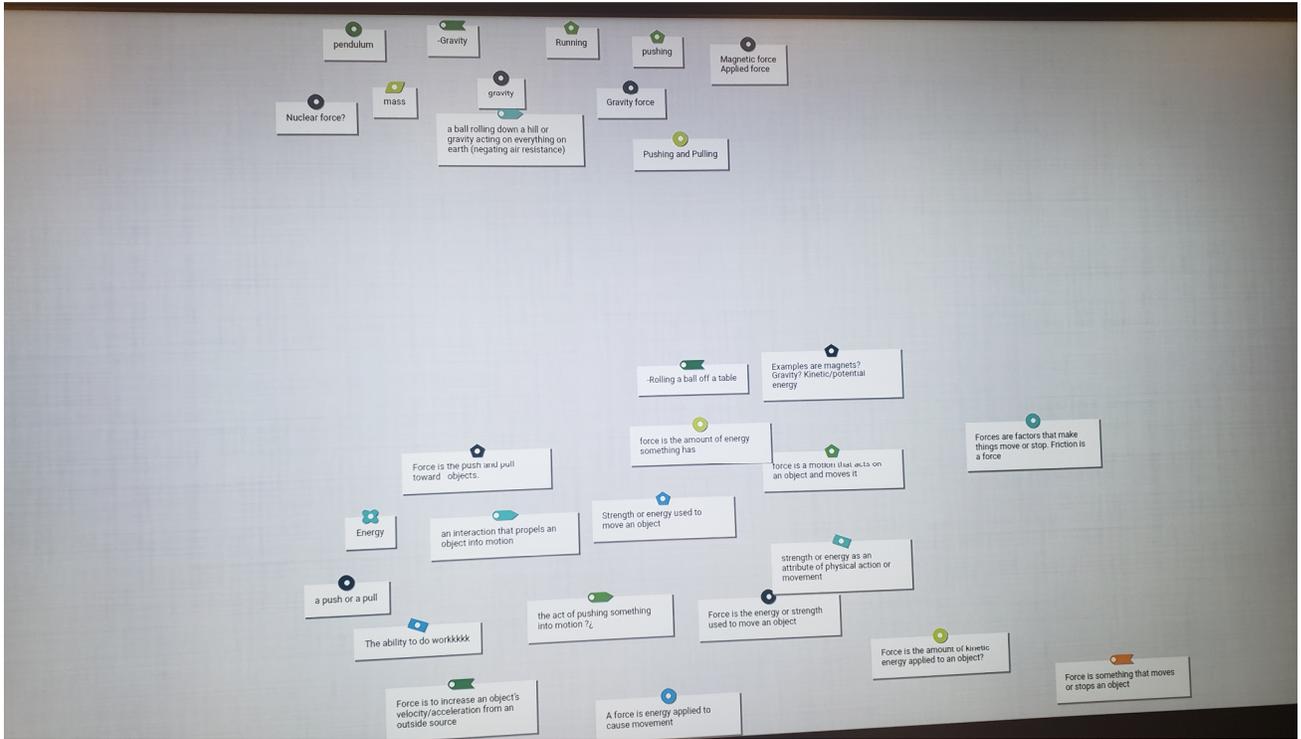
b) What their work should have looked like...

c) If was wrong because...
 The two vectors on the bottom are added as if they were negative, and instead should be flipped.



2019.11.20 – Introduction to Forces

This lesson pre-assessed student’s knowledge of forces, affirmed how forces can be categorized, discuss what a system boundary was, and established how students to represent forces (as vectors) using Free Body Diagrams (FBDs). This lesson was incredibly effective. Because it was a new topic, and because the student had just completed the previous chapter, students were able to set aside content that was weighing on their psyche in favor of a fresh starting point. The only content that was immediately transferable was vectors, which the students seemed to grasp immediately. Students were however confused on the difference between free body diagrams and vector addition (of displacement vectors) I had to reiterate several times that it is the industry standard to always have vectors start at the origin, even though that was never the case for vector addition. This will need to be reiterated and assessed in future lessons.



2019.11.21 – Introduction to Newton and N1 & N2

This lesson was modified to spend more time than was originally anticipated on drawing FBDs (Free Body Diagrams). Student seemed to understand how to draw the arrows but were hesitant and incorrect about the direction of the forces applied to the object. It is especially understandable, as we had not yet arrived at Newton’s 3rd Law.

Assessment of drawing FBDs was done via teacher walking around and looking at notebooks as students worked in pairs and independently. Unfortunately, no examples are available of this. Future assessments (outside the scope of this study) include slides with hand-written ink from homework problems where students dictated to me what to write.

This lesson also included a rap about Newton’s 2nd Law. Dr. Chis Emden, an urban educator of color, speaks about incorporating creative touchstone of verbal storytelling as his as a key tenant of reaching students in urban centers (Emdin, 2016). While Giacomini created the rap, my implementation

and participation in performing it made the experience more memorable for them. I occasionally hear a student saying the chorus as they pass by in the hallway.

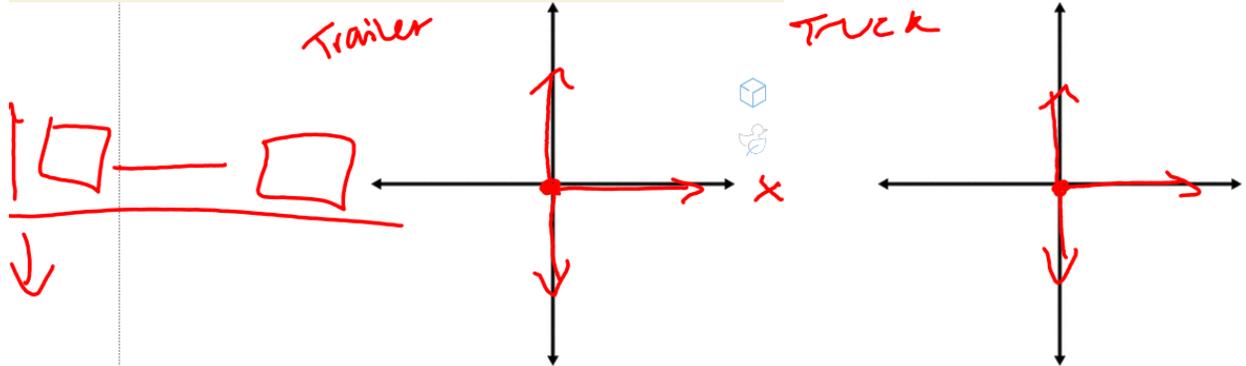
Assessment took the form of a class-wide solution to some of the homework problems. The slides from that period were written by me as the students dictated to me what to write. I would then correct their descriptors, evidence statements, and vector directions. The first graded assessment of this material will be assigned on 12/5/19 as a Newton and Forces Lab assignment.

2019.11.22 – N3 & Practice

This lesson continued on from the previous lesson, in that we covered Newtons 3rd law. As a modification from the original plan, I spent time creating a summary table the algebraic (but not equation) representation of the laws. This was important because they could then cite these shorthand statements when supporting their answers and calculations, similar to how they relied in previous lessons for Kinematics.

Students were again assessed by the examples they gave, questions they answered, and then how they were leveraging the questions to complete future assignments. All three Newton's laws were still fresh, and application of them would begin towards the end of the period and during subsequent lessons. An example of student showing how they completed one of the homework problems is depicted below. You can see this student's misconception about the direction of the F_t between the truck and trailer, as the forces are in the same direction.

1. A truck pulls a trailer on a flat stretch of road. The forces acting on the trailer are the force due to gravity (250 000 N downward), the force exerted by the road (250 000 N upward), and the force exerted by the cable connecting the trailer to the truck (20 000 N to the right). The forces acting on the truck are the force due to gravity (80 000 N downward), the force exerted by the road (80 000 N upward), the force exerted by the cable (20 000 N to the left), and the force causing the truck to move forward (26 400 N to the right).
- Draw and label a free-body diagram of the trailer.
 - Draw and label a free-body diagram of the truck.



Conclusions & Discussion

The modifications that I made as a result of this study fell mostly within Domain 3 and Domain 4. These changes focused around how I was interacting and communicating with the students and how I was conducting the instruction. I spend more time, and with more seriousness (no longer reading the goals as if they were merely an obligation for me to get through) so that they would intuit that the goals were in fact important. I also utilized a form of a Total Participation Technique (TPT) where I tried thumbs up/thumbs down, but to little effect. I did not notice any change with which students were raising their hands. I spent more time solving

As a result of these interventions, Test #4 (Projectile Motion) scores were surprisingly high. The average stayed about the same as to the previous tests ($\bar{X}=77.3\%$), but Giacomini noted that he did not see a large 10% - 15% drop in the average that he typically sees from the Projectile Motion test. This leads me to believe that at least some of my modifications were working. This is also evident in how students are able to draw diagrams and cite Newton's laws during discussions to support their reasoning. While there is no artifact of this, I can see the difference currently as we approach Test #5 (Newton & Laws of Motion).

As of this afternoon, all students that are speaking in class no longer need to reference their notes when choosing between sine and cosine when resolving a vector quantity. Shout It Out continues to become more effective as students become quicker at logging on. I have been receiving less joke-answers and responses have lengthened to be more than one-word responses. I think this also has to do with how I am phrasing the questions, where they are forced to give their evidence.

Moving forward, I want to continue to search for TPTs that are effective with a more mature set of students. Perhaps I should try to research ones that college lectures claim to work well in their classrooms. After all, CHS⁴ is. I also want to experiment by asking students to take a photo of their homework and upload in into a shared folder (Google classroom may already have this capability). This way I can spend more time reviewing their work outside of class time and not need to walk around the room with a clipboard during the warmup (more time to talk to students and answer questions).

⁴ Fun fact, CHS is the only high school in the country (so I've been told) that is allowed to issue college degrees. There is an old PA state statute that allows CHS to issue any degree that Temple University has within their course catalogue. They never do, with the exception of honorary general study degrees to student that graduate with honors) because the law would surely be stricken shortly thereafter.

References

- Danielson, C. (2014). *The Framework for Teaching Evaluating Instrument*. Retrieved September 2019, from The Danielson Group: <https://danielsongroup.org/resources>
- Emdin, C. (2016). *For White Folks Who Teach in the Hood...and the Rest of Y'all Too*. Boston: Beacon Press.
- Philadelphia School District. (2019, 11 27). *Data Dashboard Tool*. Retrieved from The School District of Philadelphia: <https://dashboards.philasd.org/extensions/philadelphia/index.html#/enrollment>

Bloom's Taxonomy⁵

⁵ I don't have an original document to cite, otherwise I would.

Attachments

[Link to all Attachments: Link Expires 2020.01.31](#)

1. Calendar
2. Weekly Outlines
3. Lesson Plans
4. PDF of Class Sides

November, 2019				
Monday	Tuesday	Wednesday	Thursday	Friday
4	5 NS - Election Day	6 Vector Addition Practice	7 1. Vector Practice Lab	8 2. Vector Practice Lab *Trip to TFI Vector Lab Practice
11 NS - Veteran's Day	12 3. Intro to Projectile Motion Index Cards, Parabola Shout it Out	13 4. Projectile Motion Practice Gravity Shout it Out	14 5. Projectile Motion Practice 1/2 Worksheet (Warmup and Optimal Angle)	15 6. Projectile Motion Practice à The Monkey Problem *1/2 day Sticky Notes
18 7. Test Review Day	19 Test #4 Test #4: Vector Addition and Projectile Motion	20 8. Introduction to Forces Forces Shout it Out	21 9. Intro to Newton and N1 & N2 *½ day	22 10. N3 and Practice * ½ day
25 No Lesson - Career Day	26 N2 Practice & Equilibrium	27 Forces Practice	26 NS - Thanksgiving	27 NS - Thanksgiving

Blue Box: Lesson Included In this Assignment

Red Text: Evaluation w. Artifact