Distance-Time and Displacement-Time Unit

Essential Questions

1. How does graphing on a Cartesian plane apply to the real world? Identify connections that you make between the graph and the physical phenomenon it represents. (Insight)

2. What is the difference between distance and displacement? (same/different)

3. What common elements do they share? (induction)

4. How do we distinguish between relevant and irrelevant data? What factors must be considered? (Analysis, same/different)

Objectives

1. Use what you have learned about x-y plots on the Cartesian plane to graph data on a different set of axes

2. Learn how to choose suitable scales for the axes

3. Be able to work backwards and interpret portions of the graph in terms of motion (ie: to make a suitable story explaining how a given graph might have been generated)

4. Be able to distinguish between relevant and irrelevant information in a story and organize the relevant information
5. Record, organize, and graph distance and time data.

6. Calculate average speed or velocity over intervals of time

7. Reinforce your proficiency with unit factor label method (conversion of units within the metric system and between the metric and imperial systems)

8. Generate equations of lines from a given graph.

$$Y = mx + b \rightarrow d = st + b$$

Overview

The students have studied the basics of graphing straight lines, both in Korean math class and English math class. Because our class focuses primarily on applications of fundamental concepts, I chose to focus on distance-time graphs and displacement-time graphs so the students could see how this topic can be used. The basic concepts were taught in accordance with the following textbook:

International Mathematics for the Middle Years 3 (Pearson)

Chapter 8 - Coordinate Geometry: Graphing straight lines

In this chapter there is a section that deals with basic distance-time graphs. I chose to go into further detail with word problems so that the students would get more practice organizing data in tables, distinguishing between relevant and irrelevant information, and working with distance-time graphs from different angles (designing your own problem that matches a given graph, etc.). I also decided to introduce the difference between distance and displacement. To avoid confusing the students, we only focused on one-dimensional motion (along a straight line), so that the magnitude of speed and velocity for a given interval remain the same and distance and displacement can only differ based on whether they are going away from or towards the start point.

Five students entered our school this term, so I made paid particular attention to them to make sure they were following what we had studied the previous term. I gave them the same assignment I had given to students before the summer vacation and then reviewed it with them outside of class time. Since they are particularly strong students, they had little difficulty with the material. Also, I made sure they got to the board during class to demonstrate that they did indeed have a firm grasp of the topics.

As far as misconceptions, the main obstacle I encountered was having to explain that the textbook (for the sake of simplicity) called displacement-time graphs 'distance-time graphs,' even when negative slopes (to illustrate travel toward starting point) were involved.

I planned to capture their imaginations by giving them an example of a word problem involving several of the students and then asking them to do the same (first by making a story to match a given graph and then to make a story completely of their own design and then graphing distance- and displacement-time graphs for their own stories).

At YHIMS, we design our math classes to complement the material covered in the Korean math curriculum. Because no English math text exists for such a curriculum, we rely on two textbooks (International Mathematics 3 & 4) and our own materials. We do not follow the New Jersey Curriculum Content Standards.

Rationale

The first reason I chose to take the class in this direction is that it provided allowed for a wide variety of activities. In this case, the activities are story-based. I found myself particularly engaged during Professor Carroll's Internship One class, and I think one reason was that so many of the activities and articles were story-based. I've read articles that suggest that we are naturally more interested in information presented as stories because that is typically how our brains store information. In addition, it is easy to make entertaining stories about the students and they are always more captivated by material that relates to them. Another reason to focus on this particular application is that it will lay the foundation for their future studies in physics class. I coordinated my lessons with the science teacher at our school. This can be viewed as a type of cross-curricular project-based unit. I think it's important to show students that there are not clear boundaries between different subjects and we should not think of math as a stand-alone subject. Ideally, I would like to prove to them that to truly understand anything, one must have a solid math background.

Formative Assessments

Formative assessments were conducted at least twice per class. The first time was in the form of a homework check. Before I started circulating, I reminded students of what I would be looking for by eliciting a list from them. As I circulated, students were assessed on their homework with a completion grade. Later during class, while they worked on problems independently, I checked to see their progress and gave them assistance where needed. I also made an effort to get as many of the students as possible participating in solutions on the board. Though it's impractical to get all 16 students to the board every class, I make an effort to give everyone equal opportunity to do so and make note of the students who are having difficulty. I also assess understanding by eliciting information from the students with open-ended leading questions.

<u>Lesson 1: Review distance-time unit from textbook</u>

Primary Purpose: Prior Knowledge Assessment

Timeline:

1. Homework check 10min
2. Word problem review 20min
3. Reflection 3 min
4. Review of concepts of distance and displacement, speed and velocity (science) 12min

Before we began this handout, we had finished the textbook section on distance-time. Before moving on to the more in-depth word problems, I visually inspected the homework assignment that they were to have completed over the summer vacation while the students checked their own answers in the back of the textbooks (5min). I paid particular attention to the labeling of axes with titles and units and to the ways the students chose to organize the given information.

In addition to answering any individual questions the students had, I chose a word problem (page 203 #12) to review as a class. I elicited information from the students at random and added the information to a table I constructed on the board. For more difficult questions, such as 'which assumptions are necessary to solve this problem?' I asked for volunteers. Once the table was complete, I chose students to construct different portions of the graph (12-15min).

Reflection on difficult problems from last class (2-3 min)

-what problems did you have with #12 from the last homework assignment (bus tour question – International Mathematics for the Middle Years 3, p203)?

-what is the difference between distance-time and displacement-time graphs for travel along a straight line? (bonus question for high-level students: how could we measure displacement in the case of non-linear, two-dimensional travel?, Answer: the number of units between start point and end point)

-when we're given lots of information, what's usually the best way to organize it? (table)

-what's another method we could have used to help us to process the information we were given?(diagram)

-moral: bite-sized pieces, extract relevant information and discard what's not important

-what can we do if we think there's not enough information to solve a problem? (assumptions)

Lesson 2: Story Word Problem

Timeline

1. Homework check 5min
2. Review #12, p203 12 min
3. Reflection 3 min
4. Read story 5 min
5. Organize data & graph 20min

Overview of story together: 5min

In the past, what I would do is to let A class (high-level English) try to figure out the word problems on their own or in partners. For B class, I'd go through the problem with them and elicit information from the students as to what's relevant. This time, I decided to eliminate the difficult language from B class's word problem.

Go through the story together. After each sentence (or phrase for long sentences), ask the students whether the information is important or not important. If they are having trouble, ask them what we are trying to find. Then ask them what we need in order to determine what we're looking for. Give students the opportunity to ask questions as we go through the story. They may ask questions such as 'how far is the dingbat tree from the bus stop?' or 'how far is the bus from the bondaegi cart?' Reply that if you think that there is information, what should we do? The desired answer is to make assumptions (ie: to fill in the 'blanks' to make the question solvable).

Story for A Class: Not Your Typical Walk to School (The Hook is the story itself)

The Nincompooop lives 320m from YHIMS. She leaves the house at 7:30am and walks at 2m/s for 10 seconds. Then, since she is very tired from all the homework she did the night before, she falls asleep under a dingbat tree. She sleeps for one sixth of a minute and then scrambled for the bus, lest she be late and duly thrown out the window or have her head used as a drum. The bus driver, Dingapoof, is absolutely insane when she's behind the wheel and he zooms down the road at 30m/s. Miss Power, a supposedly unstoppable force, attempts to stop the out-of-control bus to no avail; it continues to sail down the road for a total of eight seconds. Then, Dingapoof, the angry bus driver, throws The Nincompoop off the bus. She flies through the air into a bondaegi cart and hits her head. To make matters worse, a crazed penguin dancer named Do Eon dances on her head. The Nincompoop's dead for a total of one tenth of a minute, after which a chivalrous student named Jiggleface revives her and carries her at a speed of 8m/s toward the school for 4 seconds. Then they see their nemesis, Mr. Hollandski, and he is hunting them down with his shotgun for their being late. Jiggleface forgets about gallantry and throws The Nincompoop off his back, so she has to run the rest of the way at 10m/s with Mr. Hollandski hot on her trail. Before she starts running, it takes her one second to get to her feet. Draw and label a distance-time graph illustrating The Nincompoop's eventful walk to school this morning. Calculate her average speed and express it in mph, m/s, km/h and mm/day. Round your answers to the nearest hundredth of the unit of length.

Assignment: Use the information provided in this story to construct a data table similar to the one you filled in for the lab.

Story for B Class: Not Your Typical Walk to School (easier vocab)

The Nincompooop lives 320m from YHIMS. She leaves the house at 7:30am and walks at 2m/s for 10 seconds. Then, since she is very tired from all the homework she did the night before, she falls asleep under a dingbat tree. She sleeps for one sixth of a minute and then runs to the bus. The bus driver, Dingapoof, is a crazy driver and speeds down the road at 30m/s. Miss Power attempts to stop the out-of-control bus, but she fails; it continues to sail down the road for a total of eight seconds. Then, Dingapoof, the angry bus driver, throws The Nincompoop off the bus. She flies through the air into a bondaegi cart and hits her head. Then, a crazed penguin dancer named Do Eon dances on her head. The Nincompoop's dead for a total of one tenth of a minute, after which a chivalrous student named Jiggleface revives her and carries her at a speed of 8m/s toward the school for 4 seconds. Then they see their worst enemy, Mr. Hollandski , and he is chasing them with his shotgun for being late. Jiggleface forgets about gallantry and throws The Nincompoop off his back, so she has to run the rest of the way at 10m/s with Mr. Hollandski chasing her. Before she starts running, it takes her one second to get to her feet. Draw and label a distance-time graph illustrating The Nincompoop's eventful walk to school this morning. Calculate her average speed and express it in mph, m/s, km/h and mm/day. Round your answers to the nearest hundredth of the unit of length.

Assignment: Use the information provided in this story to construct a data table similar to the one you filled in for the lab. (Action)
Assume missing data is negligible (small enough that it can be ignored).

When the storyline is clear to the students, have them work in pairs or groups of three to tabulate the data and then graph the distance-time graph. Students organize information with their partners, teacher circulates the room to provide assistance where needed (10 min). Once the teacher has confirmed that the table has been completed correctly (formative assessment), graph the data (10 min).

In addition to differentiation based on English ability (A version of the story versus B version of the story), additional differentiation will be provided in the form of variable teacher assistance. Students who finish early will be encouraged to help their classmates and/or to begin working on their own story for which they will eventually create distance and displacement-time graphs. Stories should involve at least one instance of travel toward starting point so that the graphs for distance and displacement differ.

Then we read through the 'Not Your Typical Walk to School' story. I didn't ask them to organize the data right away. I first wanted to go through to make sure they understood the story. There were very few comprehension issues with A class. They asked about the new vocabulary but recognized that they didn't need to know these words to solve the problem. Some students pointed out that some of the time data was given in minutes and others in seconds. Since most of the data was given in seconds, we converted the data in minutes to seconds. I did an example on the board, emphasizing the word-by-word translation of English to math and reminding them what the suffix 'th' means:

One sixth of a minute

1 / 6 * 1 min * 60 sec / min

Some students pointed out missing data (example: the distance from the dingbat tree to the bus). If it's not mentioned, I explained, do you think it's significant? I then reviewed the concept of negligible quantities. Once the first group of students had asked these questions, I made a point to lead other classes to these necessary assumptions.

I checked the students work as they progressed through the problem. They were to have their table approved by the teacher before starting to graph. I reminded the students how to set an appropriate scale for a graph:

> Distance scale = max distance / number of grid lines along the distance axis (round up to a convenient number)

Why must we round up? Answer: If we round down, our largest values will fall outside of the grid lines (analyze)

Graph (distance-time)

Demonstrate how you set the scale (remember the 3 steps!) (action)

-label each interval with the corresponding action (ex: run, hop, etc.) and speed/velocity (analysis)

Stronger students who finish quickly are tasked with assisting groups having difficulty. Be sure to monitor interactions to ensure that the stronger students are not simply doing the work for them or feeding them the answers. Rather, they should be helping them to figure out the problem.

Review Questions

What am I going to look for in your homework? (labeled axes, neat graphs made with a ruler, scale calculations, etc.)

How do we organize data? (tables, diagrams) (analysis)

What should we keep in mind when we encounter a long word problem? (bite-sized pieces, one step at a time)

What do we do when there is not enough information to solve a problem? (make assumptions)

Lesson 3: Continuation of Distance-Time Graphs for Story Problems

Timeline

1.	Homework check	5 min
2.	Review solution of story problem (call students to board)	15 min
3.	Create own story to match given graph	15 min
4.	Check your partner's work by graphing out the story	10 min

Homework Check (5min)

I started the lesson by spot-checking each student's work while they compared their graphs with their partners' independently. If there was a discrepancy found between their two graphs, the students were instructed to establish the reason for it, correct the error and make note of the type of error it was to avoid future errors. At this point it was graded as complete or incomplete, but at the end of the unit I will collect the entire unit for their homework grade. Before circulating, I made students aware of my expectations, so that if they didn't do any of the following, they could get started on it while I made my rounds:

a. Axes labeled (units and titles)
b. Ruler used
c. Scale calculations
d. Scale indicated on graphs

Before reading through the homework problem with the students, I asked them what columns we should have in our chart. Then we read through the question and filled in the data. I pointed out that having a time of day column and a time column could make it easier to interpret the data. After filling in the chart, I asked students how we should decide the scale. They helped me with the calculations and then I constructed the axes. Students were called upon to plot different intervals of the graph.

Review solution of story problem (15 min)

Questions to ask:

1. If they didn't already ask about the things they needed to make assumptions about, point out the assumptions that they in effect made (travel in a straight line, negligible distances)
2. What would be <u>different</u> about the displacement-time graph (in this case, assuming she travels in a straight line from home to school, there would be no difference because there is no point where she goes toward her starting point). (same/different)

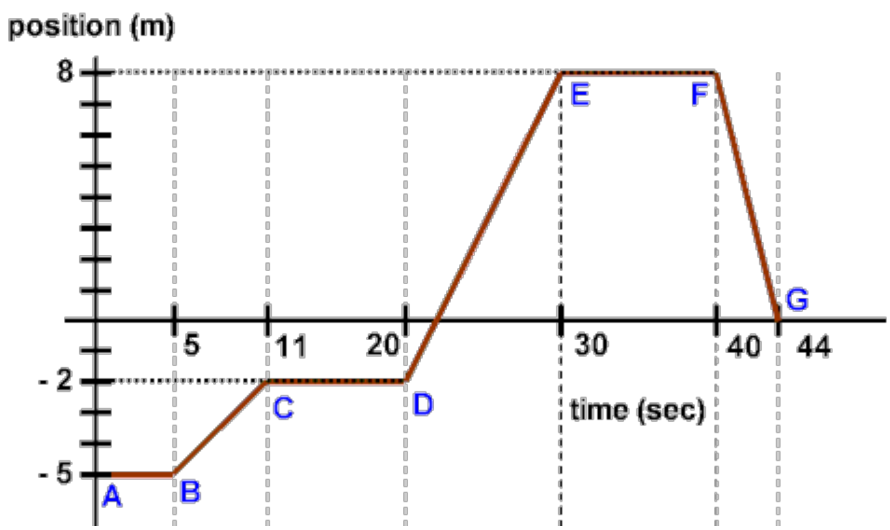
Make a Matching Story (15 min)

Make a story that corresponds to the graph below. You can use a diagram to illustrate your story, and yes, it can be funny. You can change the units if necessary. (action)

For students having difficulty, first have them label each interval with an appropriate activity. Then, make sure the relative slopes agree with the activity they selected. Prompt them to be creative about the times when their position isn't changing (ie: they can be active but their position relative to the reference point must remain unchanged).

This activity should further reinforce the students' recognition of the importance of units. In other words, without units, you can't really make sense of the graph.

Note that the starting point and the reference point do not coincide and this will likely be a source of confusion for many students. Ask them to think of a situation in real life where this is likely (ex: vertical motion relative to sea level).



Note: the next assignment will involve them making a word problem of their own for their partner and graphing the solution to evaluate their partner's performance.

Check Partner's Story (10 min)

The best way for them to do so is to generate a graph based on the story and then compare that graph to the given one. If there are discrepancies, determine the reason for them. Was an error made or was it due to different assumptions being made.

1. Compare the graph you made based on your partner's story to the given graph. (same/different)
2. What factors contributed to any differences that exist between the two graphs? (analysis)
3. What insight did you glean from this exercise? (insight)

Lesson 4: Computer Game Exercise

Timeline:

1. Share matching stories with another group 5min
2. Exercise overview before going to computer lab (distraction-free environment) 5min
3. Play the game with no restrictions 5min
4. Play the game with the goal of answering the given questions 15 min
5. Review questions in class 15 min

This exercise involves using an online resource: (http://goo.gl/phn1Q). On this site, students can navigate a spaceship through a planetary system toward its final destination: the mother ship. As they do so, a displacement-time graph is generated simultaneously. The real-time link between motion and the graph should serve to give students provide students with a more tangible connection between the physical motion and the graph. A possible source of confusion in this exercise is that the reference point is the end point, the mother ship.

The page has instructions for a two-person group. One person simply drives the space ship from point A to point B. The next person aims to drive the ship in such a way that the path generates an identical graph to the one from the first journey. That's not a bad idea, but it doesn't instruct them to explore different types of motion to see the effect that motion has on the graph. So, I came up with the following questions to supplement the exercise to ensure that the students analyze the connection between physical phenomena and the graph the program generates. It will also dispel some myths that might exist in the students' minds (ex: if I go down, the graph will go down on the screen, the graph will go down, too). There is an option on the site to show the distance from the mother ship. If you click that option, a solid line joins the small ship to the mother ship throughout the journey. This can help to show why the graph does what it does (ie: when the line shortens, the graph goes down). This can provide a segue to two-dimensional displacement. Stronger students may realize that the program uses an invisible grid to measure the changing coordinates of the space ship. It then uses the distance formula to calculate its distance from the reference point at each instant (d = sqrt((x2-x1)^2 + (y2-y1)^2). Give students the chance to establish this on their own, but even if they don't pose leading questions to guide them in that direction. Not only does it help them to gain a more thorough understanding of the topic, but it gives them provides further relevance of the distance formula they studied earlier.

Computer Activity Questions

1. <u>What happens</u> to the graph when the space shuttle isn't moving? (perception)
2. What trend do you <u>detect</u> in the graph when you move away from the mother ship? (perception)
3. What do you <u>notice</u> about the graph when you move in circles? (perception)
4. What do you <u>see</u> happening when you drive the ship down on the screen? (perception)
5. What are some <u>common characteristics</u> of distance- and displacement-time graphs? (induction)
6. In what situations should we use a displacement-time graph instead of a distance-time graph? <u>Appraise</u> their relative usefulness in at least three different applications and make a judgement on which would be best in each situation. (appraisal & evaluation)

7. What are some qualities that both types of graphs share? (induction)

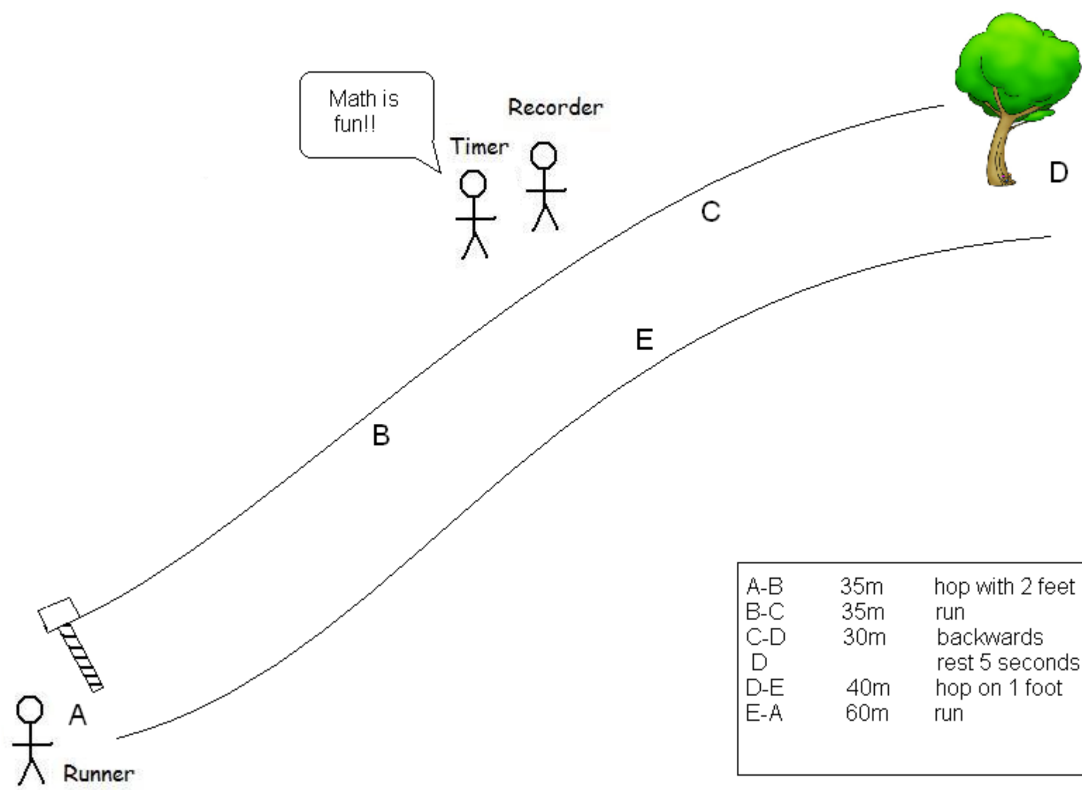
   Clue – it depends on your position relative to the mother ship. If you're above the horizontal line passing through the mother ship, as you travel down, the displacement is decreasing. If you're below that line, the distance increases as you move down. Illustrate with a diagram.

8. Is this a displacement-time graph or a distance-time graph? How do you know?
9. Predict what would be different if the computer generated a distance-time graph. (prediction)
10. What different about this graph's coordinate system? (same/different). Infer why the programmer might have designed it this way. (insight)
11. Where is the reference (zero) point? (perception)
12. Summarize what you learned during this lesson. (summary)

Lesson 5: Obstacle Course Lab (Culminating Event)

Timeline:

1. Go over directions in class — 5 min
2. Run obstacle course 3 times — 15 min
3. Data chart - first few rows together — 5 min
4. Complete data chart — 10 min
5. Graphs (remainder for homework) — 10 min



A-B	35m	hop with 2 feet
B-C	35m	run
C-D	30m	backwards
D		rest 5 seconds
D-E	40m	hop on 1 foot
E-A	60m	run

Directions:

In groups of 3 you will be running this obstacle course to help us understand how distance-time graphs and displacement-time graphs relate to what is actually happening in the real world. Each member of the group will have a role (runner, timer, or recorder). Each group will be given a turn to run the course. The runner will start at point A. When the timer says 'Go', they will start the stopwatch and the runner will run through the course from A to B to C to D to E and back to A. At each point (A, B, C, D, E, and A) the timer must yell out what the time on the stopwatch is when the runner reaches that point. The recorder then writes down the times in the chart. The following is how the race needs to be run.

Note: Only stop the stopwatch when the runner is finished the whole course. At each point along the course, simply read the number of seconds on the watch and call out the time to the recorder who will then write it down.

Bonus Question: What assumption might be necessary to make this project easier?

Assume that all travel is along a straight line so that distance is the same as displacement until point D, after which distance continues to increase whereas displacement reduces to zero. If we did not make that assumption, the calculations would become considerably more difficult and more measurements would be needed to do them.

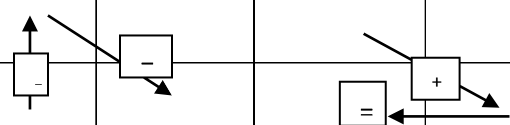
Predict

Predict what you think the distance-time and displacement time graphs will look like. Sketch them both below. Don’t forget to use a ruler! (predict)

Data Table

Write the times in table on the back then calculate the rest using the information provided, and your expertise in distance-time graphs. Then draw a graph representing your results. Make sure to label the axes and include units. (action) Label each section of the graph with the activity that the runner was doing on that interval. (analysis)

Section of Course	Time from start (s)	Time for section	Distance from start (m)	Distance for section (m)	Average Speed (m/s)	Displacement (m)	Velocity (m/s)
A to B							
B to C							
C to D							
D (rest)							
D to E							
E to A							
Average							



Note: Consider each cell to represent the position of the runner at the end of the interval

Note for generating equations for each section of the graph (below): Students generally have a lot of trouble with this because they are not used to doing it for multiple non-continuous lines on one grid. To assist them, I suggest that they extend each portion of the graph with a dotted line in either direction. This way, the students can see the approximate coordinates of the y-intercept, so they'll know if their calculations are wrong. Also remind them that graphical solutions are not as accurate as solutions with equations, so they should only be using the apparent intercepts on the graph for reference or as a double-check.

Graph (distance-time)

Demonstrate show how you set the scale (remember the 3 steps!) (action)

Label each interval with the corresponding action (ex: run, hop, etc.) and speed/velocity. (analysis)

Generate and label each section of the graph with the equation of the line. (action)

Graph (displacement-time)

-show how you set the scale (remember the 3 steps!)

-label each interval with the corresponding action (ex: run, hop, etc.) and speed/velocity

-generate and label each section of the graph with the equation of the line

Class 6: Review of Obstacle Course Lab

Timeline

1.	Compare graphs with other group members and resolve discrepancies	10 min
2.	Complete table and graph one group's data as a class	20 min
3.	Find equation of line representing one portion of the journey	5 min
4.	Comprehension questions	10 min
	Homework: Critical Thinking Questions	

Comprehension Questions

1. How far away from point A is the runner after 20 seconds? (answers will vary) (perception)

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2. At what time is the runner 100m away from the start? (answers will vary) (perception)

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3. Which point is the farthest away from the beginning? (perception)

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4. For section C to D is the runner going away from or towards point A? (analysis) Predict whether you should you have a positive or negative slope? (prediction)

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5. When did the runner go the fastest? (analysis)

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6. At what time was the slope of the graph zero? What was happening at this time? What can we induce about horizontal sections of distance-time graphs? (perception, analysis, induction)

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7. What is the total distance run? How long did it take? (analysis)

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8. What is the average speed for the entire course (Hint: look at the last question)? (analysis)

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Critical Thinking Questions

1. What does the slope of a distance-time graph indicate? (speed) (analysis)

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2. What realization did you have about when velocity and speed are the same? (when traveling in a straight line) (perception & induction)

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3. When are they different? (when there is a change in direction) (same/different, induction)

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4. Share your ideas about how you would help someone understand the difference between distance and displacement? Speed and velocity? (idea)

Here I explained that I didn't want to hear the kids regurgitate examples I'd given them. I wanted them to come up with their own examples that might help make it 'click' for someone else. This question really made it clear to me who had a firm grasp of the concept and who didn't. One example that a student pointed out was travel up and down a mountain to show that displacement is the distance from the start point to the end point through the mountain. Another great example was the distance versus displacement traveled by a piece of food that passes along our digestive tract. The distance would include the length of our intestines whereas displacement is just the distance from our mouth to the point where it leaves our body (and yes, this example generated quite a bit of giggles among the class). Displacement over long distances (map versus globe) was another great example the students came up with.

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5. Appraise your graph on how well it represents the runners speed at any given moment. How could we make our graphs more accurately represent the speed of the runner throughout his or her journey? (Hint: do we really travel at a constant speed on each stage of the obstacle course?) (appraisal & idea) (Sources of Error)

   We could have taken measurements more frequently and taken better care to make sure the course lay across level ground. Also, the way we used the stop watches wasn't the most accurate way, but it was the simplest. Using the 'lap' feature, we could have clicked the button at each pylon and then looked at the times recorded afterwards rather than just calling out the times at each pylon.

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6. Infer why is it important that the obstacle course follows a straight line to and from the tree? (insight)

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7. Predict what would a vertical line suggest on a distance-time or displacement-time graph? (predict)

This would suggest that the runner was in more than one place at one time – impossible!

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Class 7: Help Your Partner Prepare for the Unit Test with Your Own Story

Make up a story about someone or something's journey. It can be as ridiculous as you like – as long as the graph matches your journey. It should have at least five separate stages at least one of which involves travel towards the starting point

Graph (distance-time)

Demonstrate how you set the scale (remember the 3 steps!) (action)

Label each interval with the corresponding action (ex: run, hop, etc.) and speed/velocity (analysis)

Graph (displacement-time)

Report how you set the scale (remember the 3 steps!) (action)

Label the sequences of intervals with the corresponding action (ex: run, hop, etc.) and speed/velocity (analysis)

Class 8 - Summative Assessment **Unit Quiz: Distance- and Displacement-Time Graph**

Name:__________________ Class: ____________________ Score (/25): ________________

1. Label each graph with the letter for the story that most accurately represents the displacement-time graph shown. (8 points) (analysis)
    a. Big Tuna swims at a constant speed, slows down, stops to eat a pizza, and then continues traveling at a constant speed.
    b. Mr. Holland throws Mr. Good into the air. He throws him so fast that he escapes Earth's gravity. He flies through space for years and years while dreaming about potatoes.
    c. Miss Iznogood is an Olympic athlete. First she rides a bicycle, then she runs, then she has a heart attack and dies. She comes back to life as a really fast zombie. She runs back toward her start point to eat Skippy and Hulk.
    d. Foong is a very noisy badminton player – and a strange one. She plays badminton with potatoes. She hits a potato into the air and then it comes back down and smashes. And that's how mashed potatoes were discovered.
    e. Mr. Sunshine decides it is time for him to return home to the sun. He hops in his space ship *Big Garbage* and flies faster and faster, deeper and deeper into space. And then he hits the sun and disappears in a poof of smoke.

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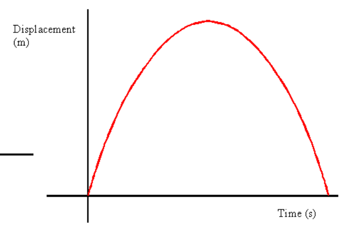

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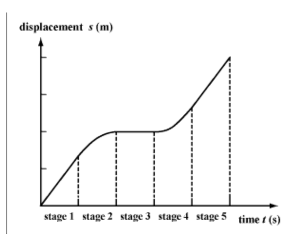

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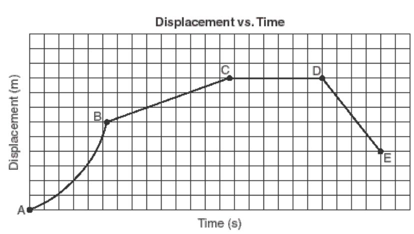

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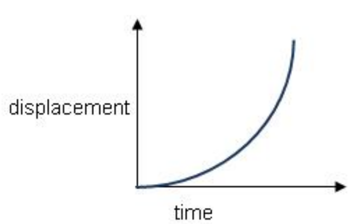

2. Rumplestapleskin is chasing Mess Machine through a bungtigi factory. For once, The Sunshine Assassin isn't on a killing mission. She's timing Mess Machine and her assistant, The Apprentice, is recording the time. She recorded the time he reached points within the bungtigi factory.

Section	Time from start (s)	Time for Section (s)	Distance from start (m)	Distance for section (m)	Average Speed (m/s)	Displacement (m)	Velocity (m/s)
A-B	3	3	30	30	10		
B-C	4	1	70	40	40		
C-D	12	8	120	50	6.25		
D-E	24	12	180	60	5		
E-F	50	26	250	70	2.69		
F-B	100	50	470	220	4.4	30	
B-F	200	100	590	220	2.2	250	

a) Complete the chart. (2 marks) (action)
b) Calculate the scale for a displacement-time graph (2 points) (action)
c) Draw and label a displacement time graph (axes, points, scales) – 10 points (action)
   - Note: you do not have to label the intervals
d) What assumptions did you make in calculating the displacement? (1 point) (analysis)
e) Bonus: Generate the equation of the line representing the B-F portion of the journey (1 point) (action)

Prior to the unit test, I collected each student's handout for the unit which I later evaluated. Some students had their handouts done more or less perfectly, but then did very poorly on the test, which I determined to be further evidence of a problem involving copying homework.

Reflection

I felt confident going into the lesson because the students enjoy material designed especially for them. Each student received a handout for the entire unit. Students were expected to have all other necessary materials. I made this question last year and I changed the names to reflect this year's students, but I noticed in the first class that I'd forgotten to change one of the names, making it difficult for the students to understand what was going on, so I made the necessary changes for subsequent classes.

Our students are particularly over-worked. They have 10 regular classes and 6 after-school classes. They are forced to sit down for the vast majority of their 8am – 5:30pm day. I think in the future, I'd like to have a story they could act out. Anything to get them out of their seats has a positive effect on their attitudes and energy levels. It would also have the added benefit of immersing them in the data. Having that physical and visual connection to the data would certainly add to the level of engagement of the class.

Another option is to record the story in a video. It could even be an assignment given to the film-making class. The downside is that it wouldn't get the students out of their seats in math class, but it would provide for a culminating event in film-making class and make the whole process more fun for the students while they study math.

An example of the type of moment that's difficult to plan for is students falling asleep in class. The rule of thumb in Korea for high school students is that if you're sleeping more than four hours per night, you're not working hard enough. I would say the corresponding rule of thumb for middle schoolers is around 6 hours, but many get less. The only thing I can do is to incorporate more kinesthetic learning in my classes. I can also advise them on planning their study schedule in their planners. Keeping them active should keep them awake, and, as someone who has a difficult time staying in one place for long, I fully understand (and too seldom provide for) the need for the opportunity for students to get out of their seats. I would welcome any suggestions on how to do so.

In the future, it might be a good idea to make an effort to pair a stronger student with a weaker one so that the stronger student may coach the weaker one. Both students could benefit from such an arrangement. Another thing I realized I don't do enough of is to convey instructions via multiple forms of media. Many times, I state my instructions clearly, and a paraphrase to clarify, but I don't write them on the board. It has baffled me in the past that some students are still lost even though I've given them what I perceive to be very clear directions, but I have to admit my own oversights. Some students respond better to written directions. An example of how I noticed the need for this is the number of students I had to remind to organize the information in charts before graphing (after they'd seen it demonstrated and heard it stressed in multiple ways). I could have saved myself a lot of frustration had I just written simple step-by-step instructions on the board. The most effective way to do this might be to explain it and then elicit the steps from the students while simultaneously writing them on the board.

As far as external factors that affect the way I conduct my class, Korea is a fiercely competitive society. Students and parents are obsessed with fairness to the point that will complain vehemently at the slightest perceived hint of unfair advantage. This is why the concept of differentiated evaluation is simply not an option for me and it's hard for me to imagine how it's possible anywhere past fifth or sixth grade. I didn't catch any flack about differentiating with respect to English level for in-class activities, but I imagine that even a variation in the difficulty of homework would cause a minor uproar. For tests, there's just no way I could have different tests for different students. And that's unfortunate because we have students ranging in socioeconomic level from the heir to the Samsung throne to North Korean immigrants (we accept 20% low income students and their tuition is sponsored in part by the school, in part by the government, and in part by members of the Young Hoon community). How can they be evaluated on a level playing field without crushing the disadvantaged students? That remains to be discovered.

I don't normally collect their homework assignments as I have 160 students, but I will for this unit, as I warned them at the start. The knowledge that it will be graded – and not just a completion grade – gives them added incentive to take pride in their work. While circulating in class as the students worked on assignments, I paid particular attention to the students who missed classes. Luckily, no one missed more than one class, so it wasn't too much of an issue this time. Another quirk of Korean parents is that they send their kids to school, sick or not. I also made sure to call them to the board once they returned to gauge how well they were following the new material.

Overall, I'm happy with the way the lesson went, but I do acknowledge that there is room for improvement. I think the things I'd like to focus on most are kinesthetic learning and incorporating technology into this lesson. Victoria Johnson, a Team Leader at my school, observed my class and she had three main suggestions:

- Make sure to involve EVERY student (apparently there were 1-2 I failed to engage directly during the actual lesson)
- Elicit the relevant information from the story from the students. Apparently, sometimes I hinted too obviously (with the tone of my voice) at which information should be retained and recorded and which should be discarded
- Make instructions and expectations clear both verbally and on the board

It's also worth mentioning that I'd learned a lot from past mistakes in the past as this is my second time teaching 8th grade math. For example, in the past, I might have simply asked the students to the computer activity as indicated by the instructions on the website, but now I realize that without more structure, much of what I intended for them to glean from the exercise would be lost on them. Only the keenest of students would be going out of their way to establish a relationship between the physical phenomena they controlled and the resulting graph. The vast majority of them would be moving the planets around and just playing around on each other trying to obstruct their partner's path to the mother ship. Activities need to be structured if they are to be successful. Particularly for students this age, the amount of freedom given students can be a deciding factor in the degree to which the activity is successful.

QFL Reflection

The QFL model gave me some great ideas on how to vary and clarify my existing questions, and it gave me a lot of ideas for new questions altogether. I think it's a great model to stimulate different types of thinking in students, and I've already shared it with my colleagues. I've already got a copy of the model posted at my desk to assist me when designing lessons. I think the solution seeking cycle in the textbook will also be very useful in instilling a structured problem-solving approach in my students.