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MSUrbanSTEM
Dream It: Phase II
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Making mathematics real – connecting Algebra and Physics

Identify Desired Results

The focus of looking at the world from a new lens *and* making connections for the students tie into my overall *Dream It* project theme: Making mathematics real – connecting Algebra and Physics. By the end of the year, I want my students to see the connection and relationship between mathematics and sciences, more specifically behind Algebra and Physics.

I want my students to be able to use common vocabulary and common problem solving strategies and methods for both classes. I want my students to be able to develop an arsenal of thinking weapons to be able to attack both content areas creatively yet deliberately. One of the main concepts I push my students to develop is the skill of mental math. Some things I ask my students to always consider are: what would a reasonable answer look like, what are the approximate values the solution should be between, and what answers are not possible. By asking these questions, it helps develop number sense, which is recognizing the components a larger number is made up of (one, tens, hundreds, etc.) and eliminating unlikely solutions. Ideally, this will help students develop a conceptual understanding through number manipulation. Another thinking weapon I push my students to develop is being open to another method. So often students want a recipe to get from point A to point B – through varying activities, Math Talks, Problem of the Week, Math Puzzles, etc., students will begin to understand that we learn more from the process than the product, that we learn more from

sharing our ideas and asking questions than just asking for the answer. This is not only a mindset shift, but also a critical thinking tool.

Some ideas of collaboration and overlap I have from the beginning of the school year are the following topics: dimensional analysis, linear functions, linear (constant) motion, non-linear functions, and non-linear (acceleration and deceleration) motion. The 9th grade physics teacher and I plan to map out the year together aligning major topics in an effort to integrate the two content areas, and then we intend on further aligning the sub-topics as we cover them in detail throughout the school year. For example, when students are doing dimensional analysis in physics, they may be presented with some would you rather scenario problems, such as a #QuickFire challenge: *Would you rather earn a quarter for every inch in one mile OR earn a dime for every hour you've been alive? How old do you have to be before it is more beneficial to take the money based on hours alive?* A problem such as this lends itself well, and dimensional analysis is efficient and useful. Or when cover linear functions and graphing in algebra, the students are experimenting with linear motion of cars and creating time vs. position graphs and linear equations. An Algebra and Physics lab tied to the linear motion of two cars could help students develop deeper understandings of slope intercept equations and slope or rate of change, the importance of being able to reason and solve a system of equation in real context, and effectively interpreting a time vs. position graph in the context of the lab.

This collaboration and integration helps the students make their own connections between content areas and makes the subject matter more tangible and meaningful, resulting

in deeper understanding and authentic learning. In addition to the content, all 9th grade teachers are using the same *Discourse Rubric* used and developed by our Humanities team. Common language and expectations helps students develop a deeper understanding of what good discussion is and sounds like. The rubric will be used on a daily basis for *Math Talks* and will be expected to be implemented by students for daily group work.

Determine acceptable evidence

Over the course of the school year, students will need to demonstrate an understanding of topics and material we cover in class. Aside from unit exams, there will be other methods to measure student understanding. Depending on the unit, varying performance understandings will be asked of students, and the assessments may be, but not limited to, performance tasks, labs, projects, and written reflections.

A performance task is a short task where the questions are tiered – the first few questions are entry level questions which all students should be able to answer correctly, and the questions get progressively more difficult. This ramping up of difficulty provides students with confidence at the start, and allows you to really push student thinking. Performance tasks will provide me, the instructor, with insight about where students are in terms of understanding. This is also an opportunity for students to showcase higher level applied understanding of the topic.

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Another assessment for learning I intend on using in class is a mathematics lab. These labs will have strong connections to the Physics course, and the material being assessed will be on material being simultaneously taught in the two courses. An ideal mathematics lab would involve our Vernier tablets and motion sensors – prior to the lab, we would have a discussion and a pre-writing assignment about the students' initial thoughts and beliefs of the topic. For example, when interpreting time vs. position graphs and analyzing movement, students are presented a series of graphs and are asked to interpret various stages of the graph. Additionally, students are presented with a scenario and asked to draw their own graph interpreting the scenario.

After the pre-writing, students will then use the lab material and create their understanding of time vs. position graphs. Some activities for this lab may include, but are not limited to, asking students to describe what their group did in order to create a similar graph to the given graph using the Vernier tablets and motion detector, have students draw their graphs from a given scenario, and given a table of data points, have students create a graph and a story to match up appropriately to the data. A similar exercise can be done later in the school year as we begin to explore non-linear functions in Algebra, and the students begin to study acceleration and speed in physics.

A project which is used to assess student learning may cover systems of equations in the context of comparing cell phone data packages. Students are given several different plans, and are asked to create equations, tables, and graphs to represent each of the scenarios. In

addition to comparing and choosing the plan that is most appropriate for themselves, students will be asked to identify the break-even points, intersection points, and discuss the meaning. This particular project lends itself to the integration of technology through spreadsheet – students can input the data, create accurate graphs, and easily identify the intersections for more precise interpretation.

Finally, another learning activity involving graph interpretation could be showing short video clips, and having students graph what is happening in the video. For example, provide a fifteen second video clip of a person at the park climbing up the slide, pausing, and then going down the slide. The video will play two or three times and students would create a graph time vs. position of the person in terms of height off the ground – following their graph creation the students could share and discuss with their partners. This activity pushes students to take a real scenario, find the meaningful information and interpret what is happening in order to produce an accurate graph.

Plan learning experience and instruction

Topic	**Learning Activity**	**Time**	**Assessment**
Dimensional Analysis	Would you rather scenarios	On-going	Student work on table white boards and informal class discussions
Interpreting and Creating Graphs	15-second video clips	On-going during my third unit	Student created graphs based on video clips
Interpreting and Creating Graphs	Flag Hoist	A one-time activity used to introduce the idea of time vs. position graphs	Student discussion using the *Discourse Rubric*

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The assessments for learning tend to be a bit lower stakes for students, yet the problems and tasks given tend to be deeper, more exploratory, and open for interpretation and discussion. It also provides me an opportunity to provide meaningful feedback in the moment, creating a greater focus on the process of learning through experimentation and experience. The purpose of the learning assessments is to support student learning and to communicate that learning to others.

As of result of the *Would you rather…* scenarios, students will be able to explain and make a connection to dimensional analysis. Since dimensional analysis will be informally taught, and students will first engage with these scenarios (*Would you rather…* Earn a quarter for every inch in one mile OR earn a dime for every hour you've been alive? *Challenge*: How old do you have to be before it is more beneficial to take the money based on hours alive?) without being introduced to unit rates and conversions, the students will have to take their own path to finding an answer. After doing these scenario problems, students should be able to convert units back and forth using a method, and being able to explain why it works. Additionally, students will be able to identify that you are not changing anything about the problem, but rather manipulating the number presented so that you can compare two similar items.

The *Flag Hoist* discussion will help introduce the idea of time vs. position graphs and the importance of units. Through this activity students will engage in discussion using the *Discourse Rubric* previously mentioned, and will explore six different graphs and try to reason their way about the different graphs and come to a class consensus about which graph bets describes the

scenario. Additionally, a motion detector will be used along with a flat white board hooked up to a pulley system, which will serve as our flag, in order to help students work through this discussion providing deeper explanations and specific evidence.

Lastly, the fifteen second video clips will provide additional support and opportunities for students to demonstrate their understanding of graphs. The students will interpret short video clips and create accurate graphs to represent what is happening during each second of the video clip. The graphs will reflect student understanding of video interpretation and analysis, creating graphs, plotting data points, and synthesizing a cohesive explanation that matches their graph and the short video watched.