PLTW GTT ST Science Frameworks

PLTW Course: GTT Science of Technology

Science Strand being addressed: Physical Science

Sub-strand being addressed: Motion

Overview:

Science Standard and Benchmarks: 6.2.2.1.1

Science Standard 6.2.2.1: The motion of an object can be described in terms of speed, direction and change of position.

Benchmark 6.2.2.1.1: Measure and calculate the speed of an object that is traveling in a straight line.

Correlation to AAAS Atlas:
MN 6.2.2.1 = AAAS 4F/M3a

Essential Understandings/Big Ideas:

Students collect data from their dragster races and calculate:

Velocity (meters per second) = Distance (meters) / Time (seconds) ; **The average acceleration** (Acceleration = Velocity / Time) or (Acceleration = $Velocity_2$- $Velocity_1$ / $Time_2$-$Time_1$) ; **The force that acted on your dragster** (Force = Mass X Acceleration).

Being able to recognize and solve proportional relationships problems in real-world mathematical situations is important at school, at home and at work. When students practice this they improve their abilities in multiplication and division and build on their understanding of math concepts.

What should students know and be able to do [at a mastery level] related to these benchmarks?

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems.
- Understand meanings of operations and how they relate to one another.
- Use reasoning about multiplication and division to determine equivalent ratios and rate problems

- Apply appropriate techniques, tools, and formulas to determine acceleration and force.
- Understand how proportional relationships of variables effect mathematical results.

Misconceptions:

Student Misconceptions

- When students multiply and divide fractions, they get rules of denominators and numerators mixed up.
- When students multiply and divide mixed metric system numbers, they get the rules of conversion mixed up.

Teacher Resources:

Teacher Notes

- Students will experience opportunities to use measurement when making a sketch or drawing or a prototype and when using computer modeling systems
- Reinforce the concept that accurate measuring with precise tools and quality workmanship makes a more successful final product.

What is it that students struggle with the most and how can the teacher most effectively help students learn the concepts?

- Data collection and plugging it into the various formulas.
- Label results in a manor that enables them to students correctly plug data into correct part of the formula.

Additional Instructional Resources

Forces PowerPoint (in Google Docs GTT Resources / Science and Technology)

New Vocabulary

- **Evaluation:** The collection and processing of information and data in order to determine how well a design meets the requirements and to provide direction for improvements.
- **Force:** The influence on an object which causes it to accelerate.
- **Friction:** The resistance that one surface or object encounters when moving over another.

- **Gravity:** The force that attracts a body toward the center of the earth, or toward any other physical body having mass.
- **Model:** A visual, mathematical, or three-dimensional representation in detail of an object or design, often smaller than the original. A model is often used to test ideas, make changes to a design, and to learn more about what would happen to a similar, real object.
- **Prototype:** A full-scale working model used to test a design concept by making actual observations and necessary adjustments.
- **Speed:** The magnitude of the total distance traveled divided by the time elapsed.
- **Test:** A procedure in which the performance of a product is measured under various conditions

Vignette:

Students in GTT class have designed dragsters which are being raced using compressed air (100psi) on a flat track. As the students begin to race their vehicles, they notice some go straight down the track, some pull to the left and others pull to the right. The GTT teacher talks about forces, such as friction which are acting on the car and how it can affect the performance of the dragster. The teacher reminds students to adjust the dragster wheels so they do now touch the body allowing approximately 1 to 2 millimeters of movement between the inside of the wheel and the outside of the dragster body.

Once all students feel their dragsters are running straight, the GTT teacher asks students how they know which dragsters are the fastest. One student says mine is because it beat John's. The teacher replies "but what about all of the other student's dragsters that you haven't raced?" "How can you determine if your car is the fastest of the whole class?"

Several students said race them all together. The teacher reminded the class this was impossible as the track could only accommodate two dragsters at once. Another student said "by their speed". This led to a discussion of how speed is measured.

The discussion about speed included "miles per hour", "kilometers per hour" and "meters per second". It was decided that using meters per second would be best due to the size of the dragsters and length of the track. Using meters per second would be a more accurate method of calculating speed of their dragsters. The discussion included information about how to find the average velocity.

The students measured the length of the track and used stop watches to see how long it took their dragster to go from start to finish for three races. They recorded this data on a chart in their Engineering Notebook, and listed their average velocity on the chalkboard for the whole class to see. Students were then able to calculate the total average velocity of the entire class and record this in their Engineering Notebook.

The teacher now changed the psi of the starting mechanism to one that students did not know. The class raced their dragsters again and recorded the new information in their Engineering Notebook.

The teacher then uses the classroom document camera to share with the class results of the different races at different psi. This helps students finish the chart in their Engineering Notebook.

Assessment:

Assessment Methods

1. Compute the average velocity with the following formula.

Velocity (meters per second) = Distance (meters) / Time (seconds)

Enter your data on the class list. From the class list, find the average velocity and mass for everyone's dragsters.

Your Data				
Attempt	**Distance**	**Elapsed Time**	**Mass**	**Velocity**
1				
2				
3				
Average Velocity				

The average mass for the class is found by dividing the total mass by the number of dragsters. The average velocity for the class is found by dividing the total of the average velocities by the number of dragsters.

Class Data				
# of Dragsters	**Total Average Velocities**	**Total Mass**	**Class Average Mass**	**Class Average Velocity**

2. Compute the average acceleration with the following formula.

Acceleration = Velocity / Time

or

Acceleration = $Velocity_2$- $Velocity_1$ / $Time_2$-$Time_1$

Enter your data on the class list. From the class list find the average acceleration for everyone's dragsters

Your Data with Known Force (100psi)					
Attempt	**Initial Velocity**	**Final Velocity**	**Starting Time**	**Final Time**	**Calculated Acceleration**
1					
2					
3					
Average Acceleration					

Your Data with Unknown Force					
Attempt	**Initial Velocity**	**Final Velocity**	**Starting Time**	**Final Time**	**Calculated Acceleration**
1					
2					
3					
Average Acceleration					

3. Compute the force that acted on your dragster using the following formula.

Force = Mass X Acceleration

Known Force	**Average Acceleration**	**Mass (g)**	**Calculated Force (Newtons)**	**Known psi**
Unknown Force	**Average Acceleration**	**Mass (g)**	**Calculated Unknown Force (Newtons)**	**Estimated Unknown psi**

4. Identify forces other than the compressed air acting on your dragster. List at least two and make reference to where they affect your dragster.
    - Mass – Weight of the dragster
    - Friction - The resistance of dragster wheels over track

5. What can be done to counteract the unwanted effects of the forces you listed in #4?
    - Make dragster lighter
    - Sand wheels making less surface tough the track

6. Is there a relationship between mass and average velocity for the class results?
    - Yes. Less mass equals greater velocity

7. Do you know of any conditions that could have affected the performance of your class when compared to the other classes? What were they?
    - Overall total mass of dragsters. Less mass equals greater velocity.

Differentiation:

Gifted and Talented

- Have the student record their data onto a graph and write a paper about the results.

Special Education

- Students on an IEP and those who struggle could have extra handouts and related materials (computer simulations, videos and Internet links) made available to them.

English Language Learners

- Much of the vocabulary used in this area can be difficult for the ELL student. Using pictures that are shown in the build sheets could help. Completed examples of the design process would be of assistance to the ELL students.
- This information would have to be reinforced through the help of the ELL teacher

Parents and Administration:

Administrative/Peer Classroom Observation

Students Are:	**Teachers Are:**
Building dragsters	Questioning students
Documenting problems	Monitoring progress
Adjusting and making changes	Reinforcing success
Testing and Evaluating	Redirecting problems

Professional Learning Communities:

Reflection – Critical Questions regarding the teaching and learning of these benchmarks.

- In what areas did students perform best and what weaknesses are evident?
- How can this content be connected to other benchmarks in learning?
- Do students see the connection between acceleration and their models?
- Are students interpreting information correctly?
- What areas did students perform best and what weaknesses?

Materials – suggest articles and books for book study with PLC ~ Science of speed

Parent Resources:

http://www.nasa.gov/audience/foreducators/k-4/features/F_Escape_Velocity.html
http://www.science.org.au/nova/058/058act.htm
http://www.science-class.net/Physics/force_motion.htm
http://www.ehow.com/list_6471098_speed-activities-middle-school-students.html

References:

- Project Lead the Way , Gateway To Technology, Science and Technology course curriculum
- AAAS Benchmarks
- http://www.project2061.org/publications/bsl/online/index.php?home=true