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A Better Road: Improve Teaching and Student Morale through Standards-Based Grading

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A Better Road

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IMPROVE TEACHING AND STUDENT MORALE THROUGH STANDARDS-BASED GRADING

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ABSTRACT: This article explores the benefits of using a standards-based grading system. Examples of how such a system is used in a high school physics course are also provided.

Standards-based grading (SBG) makes use of standards as benchmarks through which student learning is evaluated. Rather than accumulating points over time, students are evaluated based on whether they understand the standards. With SBG, teachers are free to assess and re-assess what they want, when they want, and how they want without worrying about how many points an assignment or problem should be worth and how it will affect the quarter grade.

Assessment Over Time

Figure 1 is a quiz I gave last year on constant velocity motion. Before SBG I would agonize over assigning point values and giving partial credit. The SBG version simply links the problems to the standards. A single problem can address multiple standards. Consider how students must be able to interpret the position-time graph given (standard CV.6) and be able to draw the corresponding motion map (standard CV.4) in order to successfully answer problem 2a. A single standard can be assessed with multiple problems. For example, students must be able to tell me both Larry's distance (problem 1a) and displacement (problem 1b) in order to demonstrate mastery of standard CV.1 SBG sets you free!

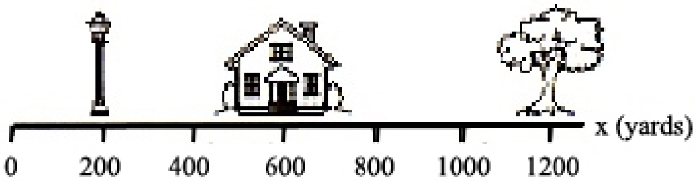
Unlike traditional assessment systems, SBG has reassesement naturally built in. After the quiz above, we

FIGURE 1
Sample SBG quiz on constant velocity motion. Originals available at http://www.scribd.com/doc/36806765.

NAME: ____ DATE: ____________________

CV.2 – I know the difference between position, distance, and displacement.
CV.5 – I can solve problems involving average speed and average velocity.

1. Larry leaves home at 9:00 and runs at constant speed to the lamppost. He reaches the lamppost at 9:10, immediately turns, and runs to the tree. Larry arrives at the tree at 9:15.



a. What is Larry's distance for the entire trip?
Explain/justify your answer.

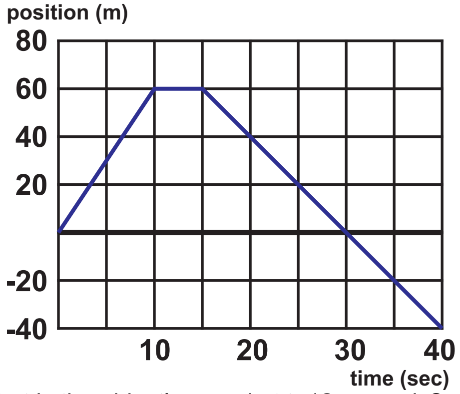
b. What is Larry's displacement for the entire trip?
Explain/justify your answer.

c. What is Larry's average speed for the entire trip?
Explain/justify your answer.

d. What is Larry's average velocity for the entire trip?
Explain/justify your answer.

CV.4 – I can interpret/draw motion diagrams for objects moving with constant velocity.
CV.6 – I can interpret/draw the position vs. time graph for an object moving with constant velocity.
CV.7 – I can interpret/draw the velocity vs. time graph for an object moving with constant velocity.

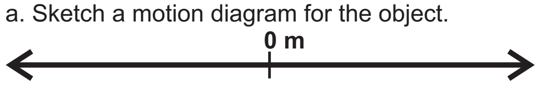
2. Shown below is a position vs. time graph for an object.



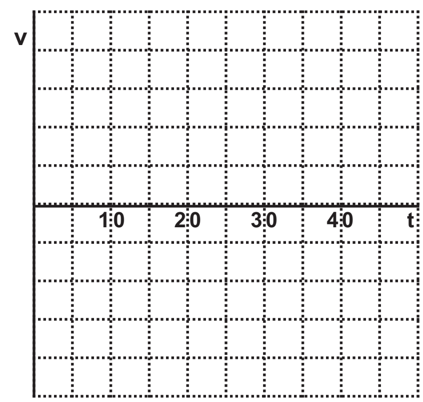
b. What is the object's speed at t=12 seconds?
Explain/justify your answer.

c. Describe the motion of the object from t=15s to t=40s.
Explain/justify your answer.

a. Sketch a motion diagram for the object.



d. Draw a second corresponding velocity vs. time graph for the object. Number the vertical axes.



continued our work on constant velocity motion. The unit concluded with a lab practical in which students simulated the tortoise and the hare story with two toy buggies, one fast and one slow (Figure 2). The "tortoise" was given a head start, and students had to determine where and when the hare would pass the tortoise. Notice this is the first time for assessing CV.8 and the second time for CV.6. Additionally, I've used this assignment to assess students on both lab process standards and constant velocity content standards. In the past, I would have lumped everything together as a "lab grade." This one dimensional report to students does not provide the detail of information students gain from knowing which standards they have, or have not, met.

Later in the year, when we are investigating conservation of momentum, I can reassess on some of the constant velocity standards to check for retention. Notice in Figure 3 that CV.4, CV.6, and CV.7 are reassessed during this assignment. By including standards from past units, students know they must retain their understanding of fundamental concepts.

Improved Student Control and Confidence

SBG makes it clear to students what they need to know and be able to do in order to be successful. With a list of standards given to students at the start of each unit, they do not have to second-guess what will be on the test. Students also know exactly why their assignments are important. Additionally, students are free to re-assess what they want, when they want, and how they want without worrying about how their past performance will impact their grade.

SBG makes clear to both teachers and students how students are progressing by clearly pointing out strong and weak areas. For example, one of my students said:

> *"I like the grading system because it helps you know what learning goals you need to focus on, and in what areas you need to study for the quiz. By putting them in those charts, we can also be aware of our progress at every point throughout the quarter."*

Here's what another former student had to say about SBG:

> *"I am very happy with the grading system for two reasons. A) it fosters success, and I believe that improves confidence. B) Physics is not easy. I, and I believe most students, do not always get it the first time. Being able to be graded on what we ultimately know improves my own stress-level, but by going over certain topics, I also get to know and understand them better."*

As you can see, this level of freedom decreases unnecessary student stress and helps them understand that learning is a journey. You can find more student reactions to SBG in an earlier post called [31 Reasons Why Kids Like SBG].

The Homework Battle

With SBG, teachers are free to assign homework without worrying about how to grade it and what to do when students copy homework from each other. Teachers do not have to collect a stack of copied work, take several hours to mark them, only to return the papers the next day to end up in the recycling bin. Likewise, students are free to tackle homework for the sake of practice without worrying about performance. And students are free to choose not do homework if they do not need the practice.

Depending upon your students' past experiences, you may even need to spend some time helping students understand the value of homework and practice. Importantly, you must trust your students and they must trust you in order for students to take ungraded homework seriously. Read about what happened when I broke that trust in a blog post I wrote: [SBG and Trust]. If students are doing homework just to jump through a hoop (i.e., earn points or please the teacher), then they are likely not mentally engaging with the work in a way that results in learning.

Improved Assignments and Activities

SBG makes it clear to teachers which of their activities and assignments are meaningful. Does this assignment help students become more proficient in my standards? Can this assignment be used to assess students on my standards? If the answer is no, away it goes!

SBG also puts a stop to baseless extra credit and pointless crossword puzzles. For example, in the past, I would give extra credit for students who submitted an entry for the Physics Challenge Problems that are in each issue of The Physics Teacher magazine. The extra credit would usually be something like dropping their lowest quiz grade, exemption from an incomplete homework assignment, or just extra points added to their quiz average. Now with SBG, I can still have students enter the contest, but I will assess their entries based on the standards that apply. I encourage students to chose a topic they are weak on and use the contest as an opportunity to grow and to demonstrate to me that growth. Now students have another method to show me what they know outside of a quiz and get credit for it!

Some Parting Thoughts

While SBG is not a panacea, consider the words of one teacher with concerns about how traditional grading held her and her students back during an egg-drop competition in her class:

> *"As they were taking apart their container to see if their egg had survived, these two students analysed the design of their container and highlighted the features of the design which made it successful. They had made a few last minute changes and they explained to me why they made those changes and how those changes improved the design. When asked, they were able to describe the physics concepts behind all the successful aspects of their design.*

FIGURE 2
Sample SBG quiz on constant velocity motion. Originals available at http://www.scribd.com/doc/36937849

The Tortoise and the Hare

Challenge: Where and when will the hare catch up to the tortoise? The hare starts running when the tortoise is _____ ahead.

To collect data, you may use motion detectors, meter sticks, tape measures, and stopwatches. Since there are a variety of possible lab designs, you may not need all of the equipment.

You may only gather data using one "animal" at a time. You may have both animals when you are ready to test.

II. Design
_____ What do you need to know so you can answer the challenge?
_____ Describe you experimental design with both **a labeled diagram** and a verbal description.

III. Data
_____ Perform the experiment and record your data appropriately.

IV. Analysis
_____ Ask you teacher for the initial separation between your tortoise and your hare.
_____ Using your data about the tortoise and the hare, solve the challenge. Part of your solution must involve a clearly labeled sketch of a position vs. time graph illustrating the scenario presented in the challenge. Clearly and neatly show all your work to determine your answer to the challenge. Divide the page with a think vertical line slightly right of center [60% | 40%]

SOLUTION	**COMMENTARY**
Your math work goes here	Your explanation of what you are doing AND WHY goes here.

V. Conclusion
_____ Ask your teacher to test you prediction. Were you correct? Why or why not?
You will be assessed using the rubric below.

LEARNING GOALS	0 - MISSING	1 - BEGINNING	2 - DEVELOPING	3 - PROFICIENT
SR.2 - I can design a reliable experiment that solves the problem.	The experiment does not solve the problem.	The experiment attempts to solve the problem but due to the nature of the design the data will not lead to a reliable solution.	The experiment attempts to solve the problem but due to the nature of the design there is a moderate chance the data will not lead to a reliable solution.	The experiment solves the problem an has a high likelihood of producing data that will lead to a reliable solution.
SR.3 - I can communicate the details of an experimental	My diagrams are missing and/or my experimental procedure is missing or extremely vague.	My diagrams are present but unclear and/or my experimental procedure is present but important details are missing.	My diagrams and/or my experimental procedures are present but with minor omissions or vague details.	My diagrams and/or my experimental procedure are clear and complete.
SR.6 - I can record and represent data in a meaningful way.	My data are either absent of incomprehensible.	Some important data are absent or incomprehensible.	All important data are present, but recorded in a way that requires some effort to comprehend.	All important data are present, organized, and recorded clearly.
SR.7 - I can analyze data appropriately.	No attempt is made to analyze the data.	An attempt is made to analyze the data, but it is either seriously flawed or inappropriate.	The analysis is appropriate but it contains minor errors or omissions.	The analysis is appropriate, complete, and correct.

CV.6 - I can draw the position vs. time graph for an object moving with constant velocity.
CV.8 - I can solve constant velocity problems requiring multiple steps and/or simultaneous equations.

FIGURE 3
Sample Momentum Conservation Assessment. Originals available at http://www.scribd.com/doc/36938119/

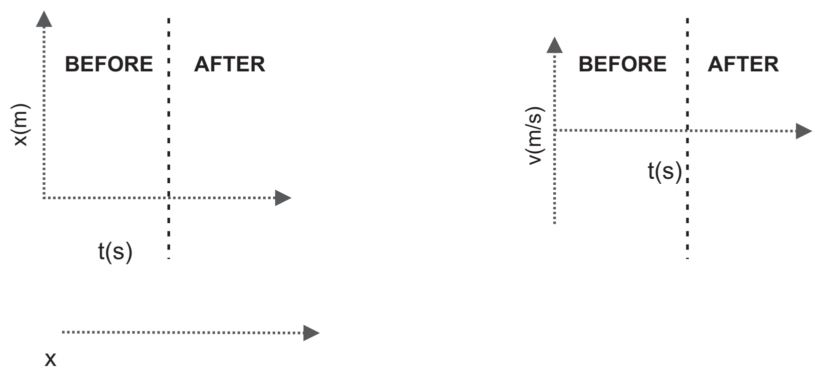
Momentum Conservation NAME ________________________________ DATE_____________

MOM.2 - I can calculate the momentum of an object/system with direction and proper units.
MOM.3 - I can draw an interaction diagram and specify the system and the surroundings.
MOM.4 - I can draw and analyze momentum bar charts.
MOM.5 - I can use momentum conservation to solve different problems.

1. Consider a collision in football between an 85-kg fullback and a 100-kg linebacker during a goal-line stand. The fullback plunges across the goal line at a velocity of 1.5 m/s east and collides with the linebacker. The linebacker and fullback hold each other and move as one.
   a. Draw an interaction diagram and identify system/surroundings for this situation.
   b. Create before and after momentum bar charts for this situation. You must label each bar.
   c. What is the **velocity** of fullbacker and linebacker as a result of the collision?
   d. Compare the fullback's **momentum change** to the linebacker's momentum change as a result of this interaction. Explain/justify your answer.
   e. Compare the fullback's **velocity change** to the linebacker's velocity change as a result of this interaction. Explain/justify your answer.

[PAGE 2]
CV.4 - I can interpret/draw motion diagrams for objects moving with constant velocity.
CV.6 - I can interpret/draw the position vs. time graph for an object moving with constant velocity.
CV.7 - I can interpret/draw the velocity vs. time graph for an object moving with constant velocity.

f. Sketch a position-time graph, a velocity-time graph, and a motion diagram for the fullback before and after the collision with the linebacker.



[PAGE 3]
MOM.1 - I can determine whether interactions are present for a given situation by considering the motion of objects.

2. A student attaches a string to a hover puck (initially at rest) and pulls on the string.
   a. Describe the motion of the puck while the student pulls the string. Be specific!

   b. Describe the motion of the puck after the student stops pulling the string. Be specific!

"As they were talking, I thought to myself, "please write all this down in your lab report" because a lab report was how I was going to assess their understanding of the concepts of physics and design. But did those brilliant, eloquent explanations appear in the lab report? No. Did those students get credit for their understanding that had been demonstrated to me? Well, it wasn't on the rubric for the lab report.

"These two students weren't unique. Another student who was able to tell me why his container had worked didn't even submit a lab report. ***At that moment I knew there had to be a better way of giving credit to students for what they have mastered.***

"Enter SBG. Imagine now that I have a time machine and I can go back to April during my practicuum. How would I deal with the same situation using SBG? For this project, I would have two forms of assessment.

- *One assessment would be the lab report with which I would score the students on two standards: (1) understanding Newton's second law and (2) demonstrated ability to effectively communicate in writing.*
- *Another assessment would be teacher observation or interview. I would record a score just for the student's ability to demonstrate understanding of the relationship between force, mass and acceleration.*

Frank Noschese *has taught for 15 years at John Jay High School in Cross River, New York. He currently teaches College-Prep Physics, AP Physics, and Conceptual Physics. Frank is a National Board Certified teacher, and received the Presidential Award for Excellence in Mathematics and Science Teaching in 2011. Frank has previously published in* The Physics Teacher *including the article Tin Foil Capacitor. Visit Frank's blog at fnoschese.wordpress.com, or contact him at fnoschese@gmail.com.*