Standard Based Grading:
A New Look at Grading

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A Masters paper
Submitted in partial fulfillment of
Requirements for the degree of
Masters of Science Education – Chemistry / Physics

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Date

University of Wisconsin – River Falls

2013

Abstract:

Standard based grading is a form of grading summative assessments (standards) on a grading scale of 0-4; a zero being little or no response, receiving a one is partial understanding, a two is having major errors with more complex ideas, receiving a three means that the student dose not forget any information, and a four means that the student applied what they learned. These grades are based on what the student knows, and can perform. The physics teachers and I decided that students needed a way to demonstrate to us that they understood the material that we present to them in the Modeling Instruction style of teaching. We switched from participation points and grading homework to SBG in the form of summative assessments (quizzes and tests). We also switched from lecture style classes to a more guided inquiry (Modeling Instruction) using whiteboards as a tool for learning and class discussion, and student misconceptions are used to format the class structure. SBG is a way to grade the summative assessments on a scale of how well they learned the material. Students know how to earn each point on the scale, and work towards gaining that higher grade. SBG has shown teachers that students are eager to learn and participate in class to prepare themselves for the standards that ultimately lead to a better understanding of the material in class.

Literature Review

Standards Based Grading is a new style of grading that is growing with teachers who are looking for a new way to grade based on student knowledge versus participation. Teachers should not be grading for completion and participation but grade for the knowledge that the student obtains in class. There are seven main reasons why standard based grading is being used in the classroom: 1. SBG produces grades with meaning, 2. SBG challenges the status quo, 3. SBG controls grading practices, 4. SBG reduces meaningless paperwork, 5. SBG helps teachers adjust instruction, 6. SBG teaches what quality looks like, and 7. SBG is a launch pad for other reforms (Scriffiny). Most teachers would agree that these seven aspects are what grades should encompass, and what class work needs to be in the long run, but can any grading system be justified like this? The best thing about SBG is the lack of the meaningless grading (participation points, daily work, etc.). Students know what they need to accomplish, and assessing it with a test or quiz is a successful way to accomplish it, teachers are now testing what the student knows and how well they can explain the knowledge that they obtained throughout the unit.

Standards that a teacher assigns to a course should be attained and achieved by all students in completion of the course. Standard based grading according to O'Conner is a grading system that is based on learning goals and performance standards. One grade is given for each learning goal; it is a way to measure achievement. The goal of SBG is to set standards that every student can accomplish and learn through out that unit. The curriculum should be aligned with the standards. O'Connor states in one of his many papers on Standard Based Grading that grades need to be meaningful, consistent between teachers, and support student learning (O'Connor, 2011). These three goals are what all teachers should strive for. Student's grades should actually reflect what they are learning in class and not if they just occupy a seat during the hour. Standard based grading is trying to inform the way students are learning, focusing on the important aspects of class, not just the random points a student can earn. SBG is saying that standards should have an important role in the classroom. Every teacher should strive for their class to have meaning to a student.

Summative assessments are to measure student's achievement in class (these are the standards), while formative assessments (worksheets) are there to help students improve throughout the unit (O'Connor, 2011). In the past, grades have been an accumulation of points (mostly worksheets), and not knowledge. With SBG students can see what is being graded and know what is needed of them. The student is either at a beginner level, approaching proficient, or advanced in the topic at hand (Reeves). The grade that the student receives is clear, and they know why they deserve a certain grade (Reeves), grades are based on what they have learned and how they can demonstrate the knowledge of the content standards (Oliver). Standard based grading is making sure that students have learned the objectives and standards for the class. Students are being held accountable for what they need to learn to be successful in the class no matter what teacher the student takes the class from. Standard based grading helps teachers make sure that they are all teaching to the same standards. Teachers have their own way of teaching but with SBG all teachers make sure the same topics are covered as well as the same assessments are being used.

According to Guskey, teachers have a very limited knowledge of grading effectiveness and of different types of grading techniques and practices (Guskey, 2004). Teachers have a difficult time with grading, teachers are not taught a certain method, and each school district / department expects different criteria. Teachers also expect different criteria than other teachers. With SBG teachers can align the curriculum to the standards that should be covered in class. Grading will still be a little subjective, but instead of a 100 point scale that has quite a few discrepancies, on a 4-point scale there are less discrepancies and the teacher knows what to expect for each grade. Teachers that teach the same topic should meet to discuss how they would grade a certain standard with all of the teachers agreeing, that way all of the teachers are grading roughly the same. SBG has six goals related to the importance of grading; communicating the achievement status of students, informing for self-evaluation, providing specific education paths or programs, incentivizing students to learn, demonstrating effectiveness, and providing evidence of a student's lack of effort (Guskey, 2004). Grades are not essential for learning but dominate the culture of our schools and of our students. SBG makes life easier for a teacher, they have the standards already prepared and teachers assess the students' knowledge on that specific standard. Students see what they received and know where to improve to both understand the topic as well as succeed in class.

SBG is a way to show students as well as parents how well they are doing in class. Grading is on the four point scale with each point saying what exactly the student has accomplished as well as what needs to be improved on. Switching to SBG is a shock to many students as well as parents, but it shows parents and students what has been learned in class. According to Deddeh "when traditional grading was used, students earning a C in class had standardized unit test scores ranging from 47% to 94%. After switching to standards-based grading, students earning a C in class have standardized unit test scores ranging only from 63% to 78%." This is a smaller range which is showing that what the students are actually receiving is showing what they have learned in that unit (Deddeh, et al). The wide range from the traditional grading systems shows parents and students that the student ranged from an F to an A for the standardized test. Traditional grading does not show and portray the real grade the student has earned.

Unfortunately SBG is not perfect for every class and for every student. SBG does show us how well the student is doing in class but does it show the student exactly how well they are learning? Do parents understand what this grading system means? Does it show the student enough information on how they did and how they can improve their grade? There is no right or wrong way to grading. Grades should "provide accurate and understandable descriptions of learning," and "use grading and reporting methods to enhance, not hinder, teaching and learning" (Guskey, 2000). Is there a correct way to grade? Grading will be a conversation that teachers and administration will have for years to come.

To go along with changing to SBG the physics teachers and I also changed the style of teaching to a curriculum called Modeling Instruction. Modeling Instruction started in the early 1990s by a professor at Arizona State University. This instruction takes a small number of scientific models and curricula to make a coherent inquiry based physics course. Modeling started with just Physics instruction and has grown to include Physical Science, Biology and Chemistry curricula (AMTC website). The main objective of Modeling Instruction is to have students investigate scientific claims on their own and try to defend their reasoning. The teacher becomes the coach/facilitator of the class, instead of the pure instructor. Teachers are using prompting questions to prevent misconceptions, and to clarify physics reasoning. Students must realize with Modeling Instruction that they might fail, and that it is okay to learn from one's mistakes (Jackson, et al).

Modeling has been demonstrated to be effective in student learning. Students in most Physics classes take a standardized test called the FCI at the beginning of the year as well as at the end of the school year. This test is made up of physics concepts and misconceptions that students have with physics. The pre-test score on the FCI is around 26% (20% is considered guessing). With traditional teachers the post-test FCI score rises to a 42%, while beginner Modelers the percentage is 52 and expert Modelers obtain post-test scores of 69%. When teachers use Modeling in the classroom students are improving more than traditionally taught physics students on this standardized physics test. Modelers say the main increase in the FCI scores is because the class is student-oriented and not teacher-oriented course. Students lead the discussions and teachers are there to help with the misconceptions and lead them to the correct situation (Hestenes).

Modeling Instruction has a sequence for each unit, starting with a paradigm lab. This lab is geared toward student discovery, lab investigation and a post-lab discussion. The labs are usually guided-inquiry, with the teacher helping out at the beginning to make sure the students start off on the correct track. Students take data, come to a conclusion and then present their findings to the class using a whiteboard. From the investigation and discussion a general model forms and misconceptions are replaced with actual physical concepts. Once the paradigm lab is completed the deployment of the later steps of Modeling Instruction comes into play; worksheets, quizzes, lab practicums, and a unit test. Worksheets are done in small groups of students with the answers presented on whiteboards that lead to more class discussions. Student worksheets correlate with the standards that are in each unit. This helps with learning a new concept and reviewing for the summative assessments. Quizzes and the unit test are graded using the SBG style to show the students how much they actually know (with a grade of 0-4). The lab practicum is right before the test, this lab is a check of understanding of the material. The lab involves a problem that needs to be solved (for the constant velocity unit two cars with different speeds need to collide). And finally the unit test wraps up the unit. Each unit is done in similar ways, with most modeling teachers using the same labs, worksheets, and unit test (Jackson, et al).

Justification for the Development

The three Physics teachers at Shakopee High School decided to change grading and teaching styles in the three courses that are offered at the high school level. The physics teachers decided to change the grading to SBG due to the fact that SBG shows teachers what the students have learned during a unit and shows the students what they have accomplished and need to improve on to do well in the course. Modeling Instruction was adopted because it is a set curriculum and based off of an inquiry-based classroom where the students lead the classroom.

The class that I primarily teach is called Foundations of Physics. This is a low level class for students that need that last couple of science credits to graduate. A majority of these students will not be going on to a 4-year college or university. They might be attending a technical school, community college or go straight into the workplace. This class used to be graded primarily on participation and daily work. This was getting hard with so many students being absent multiple times throughout the semester or gone for long periods at a time. Grading participation and daily work for completion doesn't show the understanding of the student; just if they participated during the class period or not. This class was ready for a change.

Before SBG and Modeling Instruction, Foundations of Physics class followed the MN State Standards (Appendix I). Units were picked based on what standard was next on the list or what material was available to use. Content was covered as best as possible with the material and worksheets available. Tests and quizzes were based on worksheets done in class, and not what the students were actually learning. Students were not given “I can” statements to follow and grades were mostly based on participation points.

The main issues that were encountered in my classroom before SBG were assigning grades that did not match what the student learned in class and having too many issues with absences, which led to students leaving the class with no real “knowledge” of what happened during the semester. Students were used to participation points and receiving them during a class period even if they did not do anything. A primary concern is that students should actually learn something and be able to apply their knowledge when they leave class. Using SBG students should be able to see if they learned a certain standard or not. And know how to improve their understanding of that standard. If they do not learn the standard they have the opportunity to improve.

Another reason for the change is a large and increasing number of students, and the workload associated with keeping track of participation and grading homework. Physics is growing in the school district. Last semester Foundations had 46 students. This semester Foundations has 52 students. For the upper levels of Physics there are currently roughly 120 students (full-year classes). Roughly 240 students are being exposed to the SBG system. In the future Foundations of Physics will become a full-year course and will become the only low-level course that some students will be able to take to earn their science credits.

Throughout the school year I have 27 students on an Individual Education Plan (IEP), and roughly 5 students are in the English as a second language (ESL) program. Roughly half of the students in Foundations of Physics are receiving assistance throughout the school day from other sources. So many different abilities lead to many expectations and adaptations that need to be made during the course of the class. Modeling Instruction should be more amenable to differential learning due to its discussion and group based active learning components.

Design

Foundations of Physics is currently a semester course so the basics are covered; constant velocity, constant acceleration, balanced forces, and a quick introduction to lenses, color, magnets, and electricity. When this class becomes a full year course more topics will be covered; unbalanced forces, energy, momentum, lenses, color, magnets, and electricity. Using SBG and the Modeling Instruction curriculum in class helps to make sure that students are meeting the state standards in a way that they can be successful in class. Each unit has a set of standards, roughly 3-6, that get gradually covered over the course of each unit. The standards are assessed in quizzes which lead up to a final summative assessment for the unit. Some standards are tested more than once; in this case if students do better on the standard the second time around the current grade replaces the old one. The goal of SBG is that students are gradually learning; all students have different learning abilities and levels.

For this project to work standards had to be at the level of the students in class, and have them be able to be mastered in a certain amount of time. Once the standards were written, next came using the Modeling Instruction framework to pick out appropriate leveled worksheets and to make appropriately leveled tests and quizzes. To write out the framework of the class we looked at the MN State Physics Standards. Using the MN standards (Appendix I), course benchmarks/standards were written as "I can" statements. The state of Minnesota has many standards for teachers to cover throughout the year. With implementing SBG as well as Modeling Instruction it is very difficult to cover all of these standards. The largest sub-strand that needs to be covered is motion. This takes a majority of the year for students to learn. Modeling Instruction is very hands on and student driven so sometimes it takes some time to learn the material. In the first six weeks the topic of constant velocity is covered. When this was taught using direct instruction it took roughly three weeks. To have students understand and be able to apply the topic by using Modeling Instruction, more time was needed. With Modeling Instruction the goal is to have four units done by the end of the semester (constant velocity, balanced forces, constant acceleration, and unbalanced forces), these topics are all in the motion sub-strand. After motion, some energy and an introduction to electricity/magnetism are covered.

During the summer of 2012 the physics teachers went to a workshop on Modeling Instruction. Modeling Instruction is a form of teaching that uses guided inquiry instead of direct instruction. With the modeling curriculum we started writing class standards that matched up with the curriculum as well as the Minnesota state standards. Each unit consists of formative assessments in the form of worksheets that are done during class. Once completed, groups present their findings to the class. With modeling it is a group discussion that leads towards the correct results. If the class agrees great; if not, time is spent trying to figure out what needs to be improved on.

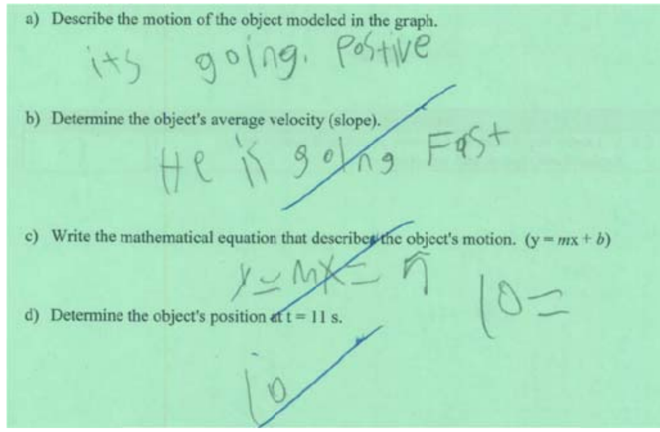
The Physics teachers got together multiple times over the summers of 2012 and 2013 to write standards and match them to the Modeling curriculum, as well as the desired outcomes for each level of Physics. Writing the standards for general and CIS Physics (College in the Schools) was pretty straightforward; Foundations of Physics was a little bit more difficult. This was difficult because the standards had to fit the ability of the students that are being taught. The learning abilities of the students in class range dramatically from low functioning to higher functioning in both math and English skills. The main objective of this class is for the understanding of the material and the ability of the student to try to solve a situation. Most of the standards for this class are qualitative, more graphs and diagrams than math problems. Understanding the concept and the ability to try and figure out the correct answer is a lot more important than if the numbers are in the correct spot.

SBG is on a 0-4 scale, and students know how to receive a two or a three. Bloom's Taxonomy lines up very well with the SBG method. Bloom's new version moves through the sequence remembering (recall or remember), understanding (explain the ideas), applying (use the information), evaluating (justify a decision), and creating (create a new product). These levels are very similar to the 0-4 grading scale of the SBG system; 0 - little or no response, 1 - partial understanding, 2 - major errors with more complex ideas, 3 - does not forget any information, 4 - applies what they learned (can go further) (Clark). The SBG scale is very similar to Bloom's Taxonomy, starting with a basic understanding and going to the level of being able to apply the knowledge that is learned. Many teachers use Bloom's in their assessments, and with using SBG it works itself into the assessments and grading in its own way. These assessments show what each student actually knows, and shows them what they need to improve on before they re-take a standard.

Since a 4 is the highest grade that a student can receive on a standard, the grading scale had to be adjusted. The passing percentage for Foundations of Physics is a 33%, which is a lot harder to obtain than students think. With SBG students are expected to know each standard that is being taught, so each student can only have two zeros to pass the class. If they have more than two zeros they cannot pass the course. This holds each student accountable for completing the entire standard, and receiving at least ones on the standards.

The standards are graded on the types of answers the student gives. The second standard for Constant Velocity states: I can interpret/draw position vs. time graphs for objects moving with constant velocity. In the standard the main points that are looked for are describing the graph, calculating the velocity, using the graph to write a mathematical equation, and lastly using that equation to solve for a distance at a certain time. Four examples of standards are below that range in scores from a one to a four.

A score of a one indicates that the student has a little understanding of what is occurring in class, so it is the bare minimum of what is expected. The first example at the right is an example of a score of one. In this example the student can identify what is occurring in the graph.


a) Describe the motion of the object modeled in the graph.

its going. Postive

b) Determine the object's average velocity (slope).

He is going Fast

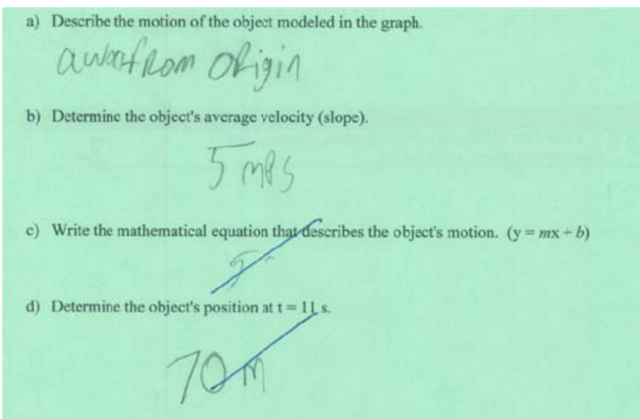
c) Write the mathematical equation that describes the object's motion. ($y = mx + b$)

y = MX = n

10 =

d) Determine the object's position at t = 11 s.

10


a) Describe the motion of the object modeled in the graph.

awayfrom Origin

b) Determine the object's average velocity (slope).

5 mps

c) Write the mathematical equation that describes the object's motion. ($y = mx + b$)

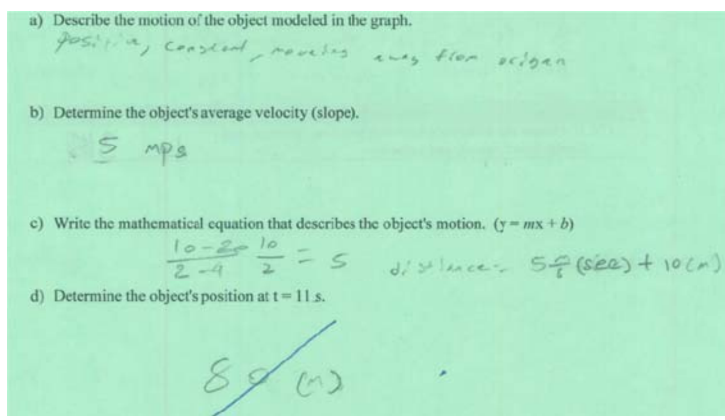
5

d) Determine the object's position at t = 11 s.

70m

A score of a two goes a little further than a one. In the second example on the left, the student was able to describe the graph, and then goes one step further and can provide the speed of the object. The student still isn't writing the mathematical equation and cannot apply the mathematical equation to calculate distance.

In the example of a score of a three to the right, the student can describe what the graph looks like, determine the speed, and can write a mathematical equation to represent the graph. This student did very well at working with the graph, and is just missing the last step to receive a four since he was unable to apply the mathematical equation to solve for distance.


a) Describe the motion of the object modeled in the graph.

positive, constant, moving away from origin

b) Determine the object's average velocity (slope).

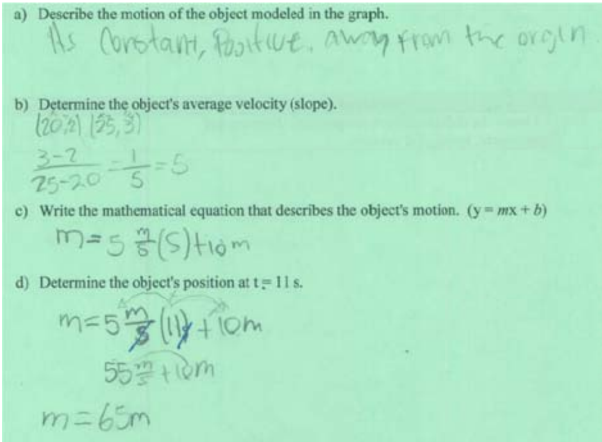
5 mps

c) Write the mathematical equation that describes the object's motion. ($y = mx + b$)

$\frac{10-20}{2-4}$ $\frac{10}{2}$ = 5 distance = 5 (sec) + 10 (m)

d) Determine the object's position at t = 11 s.

85 (m)


a) Describe the motion of the object modeled in the graph.

Its Constant, Positive, away from the origin

b) Determine the object's average velocity (slope).

(20,2) (25,3)

$\frac{3-2}{25-20} = \frac{1}{5} = 5$

c) Write the mathematical equation that describes the object's motion. ($y = mx + b$)

$m = 5 \frac{m}{s}(S) + 10m$

d) Determine the object's position at t = 11 s.

$m = 5\frac{m}{s}(11) + 10m$

$55\frac{m}{s} + 10m$

$m = 65m$

The student example on the left received a four for this standard. The student was able to describe the graph, figure out the slope, use that slope in a mathematical equation, and apply the mathematical equation to calculate the car's position at 11seconds. Based on the criteria the student earned a 4 on this standard.

Implementing the Modeling Instruction was very helpful with writing the standards as well as working with Standards Based Grading. The full curriculum for Modeling Instruction is being used in the physics classes, so with that it was pretty straight forward to determine what standards we wanted to cover in class, since we followed what was laid out in the curriculum. The MN standards were matched to the standards we wanted to cover in class with the curriculum. Everything aligned pretty well, and made the task of writing standards pretty easy. Making sure that the standards are understood by many levels of students in class, much of the class time is spent teaching graphs, non-numerical ways to read data and using diagrams. Graphs are a way to read data that does not contain a bunch of numbers, and you do not even need numbers on a graph to understand it (being able to read and understand a graph is difficult for some students but can be learned). By concentrating on graphs and diagrams it helps the students get ready for the Minnesota Comprehensive Assessment (MCA) tests and to help them be more successful in math class.

I collected data from the Constant Velocity unit for both semesters (before and after SBG/Modeling Instruction), but the grading and worksheets were different. Since worksheets do not count towards points or to their grades because they are formative assessments, only the summative assessments (the quizzes or standards) that were given throughout the unit were compared. The worksheets and the quizzes are provided in the appendices. During this unit there were multiple labs and worksheets that helped prepare the students for the standards. The five standards that were assessed during this unit are provided in the table below. There was also a lab practical at the end of the unit. The standards were graded 0-4 and the lab practical was merely fun at the end of the unit, a way to visually see if they understood the standards that were covered.

Constant Velocity Standards for Foundations of Physics:

Standard	Level	Description
CV.1	1	I know the difference between position, distance, displacement, speed and velocity
CV.2	1	I can interpret/draw position vs. time graphs for objects moving with constant velocity
CV.3	1	I can interpret/draw velocity vs. time graphs for objects moving with constant velocity
CV.4	2	I can use multiple representations, including motion maps, x vs. t graphs, v vs. t graphs, mathematical models to explain motion and solve constant velocity problems
CV.5	1	I recognize when the constant velocity model applies and I use it when appropriate
CV. LP	---	I can solve constant velocity problems in a lab situation, demonstrate the effectiveness of the solution with lab equipment, and communicate my reasoning in how the problem was solved

Constant Velocity worksheets for Foundations of Physics (formative assessments): Appendix II
Constant Velocity Quizzes for Foundations of Physics (standards): Appendix III

Results

SBG has been going pretty smoothly over this school year. Some positive outcomes are less grading (except when it is summative assessment time), no need to worry about student absences, and most importantly the ability to assess if the student has learned the material or not. Not grading for participation points for every activity or worksheet done in class really cuts down on grading time. The extra time is now available for writing more meaningful worksheets and assessments to go along with the standards. With this level of class multiple students are gone every day. For example, one Friday 10 students were absent out of a class of 25, for no other reason than it was a Friday. Keeping track of which students are gone during what lab or worksheet is quite difficult especially when grading class participation. Keeping track of absences got to be a little confusing with excused and unexcused absences. Do they get an excused for one type of absence or a zero if they just skip the class? It had become cumbersome determining whether a student would get points or not. More time is now spent helping students, writing better assessments, and analyzing if the students actually understood the standards. Using SBG there is a better understanding of how students are doing in class. If students are not doing well on a formative assessment more time is spent going over it to make sure they are ready for the summative assessments. Knowledge of what students understand and how they grasp the material has been gained while grading the standards.

Doing SBG cuts down on figuring out if students were absent on certain days with certain assignments, etc. Tests are set and if they are not in school leading up to a test or quiz it is their responsibility to be prepared for it (of course some exceptions are made). This is also the first time students are able to re-take standards. Students have the opportunity to re-take standards when they want, but it needs to be on their own time. What this means is that students cannot re-take anything during the class period, which actually makes some students work harder on the original standard so they do not need to come in before or after school to re-take a standard. Before they can re-take a standard the student needs to demonstrate they have learned the material. The ones who did not increase their knowledge of the standard cannot re-take the standard until they have shown they have learned it. As a result, many students do not re-take anything and take the original score from the original standard. This past semester two make-up days were offered to the students to have the hour to raise their grade. Unfortunately not many students took advantage of the opportunity to re-take the standards. These days were planned on days where a lot of students would be gone due to Spring Break or Holiday Break. These times are also usually when the quarter is concluding as well. Students need to take responsibility for their actions, and this holds them accountable.

SBG is a very difficult concept for some students. Students that are used to getting participation points during a class period are very undesirable of SBG. During SBG every day points do not exist, neither do participation points. Students have to earn their points during summative assessments. The first few days of the semester multiple students asked, “Are we going to get graded on this?” My answer was mostly “I don’t know”. The reason that was mentioned is because that way the student does not know if they are getting graded on a worksheet or lab. Some students do not understand that by doing class work, labs, etc. it would actually prepare them for the test or quiz that is coming up.

Implementing SBG was a little rough at the beginning of the year. Starting a new way of teaching as well as a new grading system required some getting used to. Writing assessments that are at the ability of the students in the Foundations course, creating worksheets that would keep them engaged (with some lack of motivation), and covering the standards that we wanted the students to know and understand was time consuming. Understanding how much prior knowledge the student had and their math level at the beginning of the year is tough to determine as well. Their ability levels and eagerness to learn are important aspects to consider when planning. Some students are so underprepared that they just stare at the assessments or worksheets. Sometimes they don’t understand the questions that have been written. If it was read to them, or written a different way they might understand. Each student is so completely different. While walking around the room some students are observed to be working great and others do not know where to start. This is especially hard when they also do not have the ability to ask questions (or are too afraid to). Another negative is the lack of motivation that is seen in class sometimes because they know they will not be graded on each individual activity that is done during the class period. Since the grade is based only on standards it is hard for some of these students to see past that. Students that are used to participation points work really hard during the class period, but do poorly on the standards because they still might not understand the material.

Modeling instruction has helped with the different abilities in class. Students are using more of a discussion based curriculum in class than just hearing lecturing, which leads to differential learning. Students learn in many different ways and with the ability to talk through answers with classmates (small groups as well as large groups) students are learning on their own and discovering concepts on their own time.

The attitude of the class quickly changed when participation points were no longer assigned and homework was no longer collected for credit. “Homework” turned into class work and was done and presented in class using the Modeling framework. The worksheets that used to be graded daily turned into class work that was collect during the unit test to see if they attempted, paid attention to it in class, and corrected it during class discussion. If students are absent it is up to them to see what they missed, and come in before or after school to catch up. There were fewer absences this year compared to last year; students are actually worried they will miss something important in class so they make sure they show up regularly. The class is now in the hands of the students, they are being held accountable for what they learn and how they want to achieve success in class.

Previously Foundations of Physics was taught by placing units in a random order, there was no reason for the order in which they were taught. Skipping from lesson to lesson, using random worksheets or textbook sections the students would read. Since the implementation of SBG as well as Modeling the curriculum has been much easier to follow. Modeling has a curriculum to follow; to adapt to our classes it has only been changed slightly. With SBG I have made concrete standards that need to be learned, when they will be taught, and how the students will learn these standards. Applying both Modeling Instruction as well as SBG teaching physics has become very straightforward.

While in the second round of doing both SBG and Modeling it has been getting easier to work with. Students are starting to understand that by doing the worksheets, labs, and activities while in class it is preparing them for the standards. Fewer students are asking me if this work will be graded, and more students are actually doing more work in class because they know they need to understand it for the standards.

Comparing pre-SBG with SBG is a little drastic in the grades and grading scales. Appendix IV has the grading scales for the traditional and SBG. Looking at Appendix IV table 1 you can see that the two grades are very different from each other. Pre-SBG the class scored an average of 88% on the assignments which is a B+ in class (graded using participation and completion of the worksheet). With SBG/Modeling Instruction the students scored an average of 44% which is a D+ on the SBG grade scale, and a little under a 2 on the SBG scale which means they have a basic understanding of the material presented in class. These were two different assignments but the same state standard was being covered in both classes. The pre-SBG grade assessed different worksheets than the SBG/Modeling Instruction worksheets, but both were on Constant Velocity. If the pre-SBG worksheets were graded based on knowledge the students would have scored much lower on these assignments. These scores seem very different from each other. While using both SBG and Modeling Instruction in class the questions the students are asking are better, they are participating more and seem to have a better understanding of the material. Students are struggling most with going the one step further in applying the knowledge they have obtained. Before SBG the assignments the students were given during class were graded to see if they had it completed, not if they understood it. This can be observed from the test that was taken at the end of the unit, where students received an average of 45% which is a F. If you compare the D+ with the D from pre-SBG with the students who learned with Modeling (SBG as well) scored higher. It is not a lot higher but with SBG one can tell if they actually learned something, the former way there was no idea what the students knew or what needed to be covered again. Students were able to understand the material at hand, and maybe not be able to apply it yet. It is not a drastic change but it was the first year of implementing both Modeling and SBG.

Analysis of the data from the constant velocity unit (standards) from semester one compared to semester two is in chart 1 and table 2 of Appendix IV. Semester one has a majority of twos which means that a majority of the students have a grasp of the majority of the standards, but do not know how to apply them and go that one step further. They are just having a hard time going up and beyond, but have the basic understanding. Semester two had more ones and twos, which means that a majority of the students are not quite grasping what is occurring in class. Once students are getting the grasp of how assessments are graded they see what they need to get done. Most of the time students claim that it was a simple mistake, so they can re-take a different standard and score much higher; these re-take assessments cover the same type of questions but have different numerical calculations or different looking charts or graphs. They understand what was missed to get that higher score, and fix it. The beginning of the semester started with a lot of failing grades, now fewer and fewer of them are earning failing grades. Students are starting to get the handle of what is expected and are actually studying and working harder in class to achieve that.

The data that was collect for each standard over the course of each semester is pretty similar. Semester one seemed more motivated, receiving slightly higher grades for the three standards being covered, while having fewer students during that semester. In comparing the data from pre SBG to with SBG the data is pretty dramatic. The pre SBG grading was mostly done with participation points. That is if the student had the assignment done, or mostly completed they received points based on what they had finished. The students were very good at completing the homework, with 92%, 82% and 89% of the assignments completed. The shocking part is how poorly they did on their test, with an average percentage of 45%. This indicates that the students did not learn much from doing the assignments. Assignments were just done for the points. With the tests being so poor and worth more points the grades in the class went down dramatically. Because of the poor test performance, it eventually got to the point where students could raise their grades by correcting the questions they got wrong for half credit, but this time they were allowed to use their notes. Grades went up, but part of me kept thinking that they were not learning anything by doing this. With SBG there is a better understanding that the students are learning the material we set out for them to learn.

Reflection

In preparation to finishing my MSE many teaching classes have been taken, and each one is unique in its own way. I learned about the history and school system of Wisconsin, learned how to do some extensive research as well as preparing me for this topic of Standard Based Grading. It came about in different classes when talking about the best way to grade as well as what is best for the students that we teach. Since SBG is such a new concept not many people are talking about it. But with my research and talking to other teachers using this grading system all I have heard is positive feedback. Teachers are always looking for ways to improve their classroom, make students more engaged, and understand if students are actually learning the material. If you tell your students what standards you are teaching and how you will be grading them, they are more apt to do well in your class because the students know what they need to learn. Teaching students of many different levels is the tricky part. Using differential learning in a classroom is difficult, but when the students know what teachers expect from them and how to excel, some actually do it. SBG with Modeling Instruction is a great way to implement differential learning, and make every student successful in their own way.

Teachers are constantly adjusting curriculum and teaching styles to the students that they have in class. Each class make-up is very unique. The same topics are being covered but the way of teaching it may vary greatly for each class period.

SBG is the new frontier of grading. Unfortunately in 5 years a new technique might come out and a new grading reform will need to be done, or administration might be telling teachers the form of grading that needs to be done. This project was pretty straight forward, with lots of upfront work to do to make it work. With the help of my department using SBG and Modeling was able to work. Working with others and implementing the same grading strategy really has helped me see that what I am doing is worthwhile. Grading standards together has worked very well to make sure the teachers are on the same page when assigning grades to students. To add to this project more time will be needed to adjust standards and worksheets to benefit the students better in learning the material. This semester some adjustments were made and worksheets moved around to be more useful. Standards pretty much stayed the same for each semester only the worksheets were adjusted to work for the standards. For next year this will be a full year instead of just a semester so another semester's worth of standards and curriculum will need to be developed. But this should be more manageable with a better understanding of what is needed and what needs to be covered. Since the rest of my department has the curriculum already set, adjustments would just need to be made to adapt it to the level of my students.

Students are still struggling with reading and writing in science classes. Technical reading is difficult for many students, especially the students that are in the class with lower reading skills. Giving students technical reading will help them in the long run with reading directions, textbooks, and what they are given in a future job. Writing scientifically is also missing from the standards and in Modeling Instruction. Writing lab reports and the more technical writing is also difficult for some students. In the future these two concepts should be worked into the standards for physics classes. With the amount of material that needs to be covered this makes adding these two learning tools very difficult. Unfortunately students need that extra help with reading and writing.

SBG and the Modeling Instruction lead to the use of Bloom's Taxonomy in the classroom. Bloom's taxonomy has six layers to it; remembering, understanding, applying, analyzing, evaluating, and creating. Using the SBG framework in class, students are striving for the highest grade which is a four, and according to Bloom this would be analyzing and evaluating what is being understood. A grade of one is remembering the simple concepts, with a two a student understands what the standard is, with a three a student understands and semiapplies the standard, and a four is analyzing and evaluating what the standard is all about. Bloom's method is hidden in the 4 steps of SBG. Bloom is also apparent in the Modeling Instruction. Students are conducting labs, applying knowledge to concepts, evaluating what they know, etc. Bloom is apparent in both SBG as well as Modeling Instruction.

Over the past many years I have attended many workshops on Modeling Instruction, most of these have been over the summer at Winona State University. These workshops showed physics teachers how to teach modeling and how to make it work in the classroom. This experience was classroom changing, led to many connections and discussions regarding physics curricula. Unfortunately I have not been able to attend many conferences on SBG, but research has been done on SBG for this paper. SBG is a little more controversial in some schools because of the lack of participation points. SBG has helped me to be able to separate the understanding of what is important in teaching and what is not. My physics department stood behind me this past year and will for many years to come. I have found support and guidance for implementing Modeling Instruction and SBG in my classroom.

Appendix I - Minnesota State Standards

Minnesota Academic Standards in Science

	Strand	Substrand	Standard Understand that...	Code	Benchmark
PHYSICS	1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	3. Developments in physics affect society and societal concerns affect the field of physics.	9P.1.3.3.1	Describe changes in society that have resulted from significant discoveries and advances in technology in physics. *For example:* Transistors, generators, radio/television, or microwave ovens.
			4. Physical and mathematical models are used to describe physical systems.	9P.1.3.4.1	Use significant figures and an understanding of accuracy and precision in scientific measurements to determine and express the uncertainty of a result.
	2. Physical Science	2. Motion	1. Forces and inertia determine the motion of objects.	9P.2.2.1.1	Use vectors and free-body diagrams to describe force, position, velocity and acceleration of objects in two-dimensional space.
				9P.2.2.1.2	Apply Newton's three laws of motion to calculate and analyze the effect of forces and momentum on motion.
				9P.2.2.1.3	Use gravitational force to explain the motion of objects near Earth and in the universe.
			2. When objects change their motion or interact with other objects in the absence of frictional forces, the total amount of mechanical energy remains constant.	9P.2.2.2.1	Explain and calculate the work, power, potential energy and kinetic energy involved in objects moving under the influence of gravity and other mechanical forces.
				9P.2.2.2.2	Describe and calculate the change in velocity for objects when forces are applied perpendicular to the direction of motion. *For example:* Objects in orbit.
				9P.2.2.2.3	Use conservation of momentum and conservation of energy to analyze an elastic collision of two solid objects in one-dimensional motion.
		3. Energy	1. Sound waves are generated from mechanical oscillations of objects and travel through a medium.	9P.2.3.1.1	Analyze the frequency, period and amplitude of an oscillatory system. *For example*: An ideal pendulum, a vibrating string, or a vibrating spring-and-mass system.
				9P.2.3.1.2	Describe how vibration of physical objects sets up transverse and/or longitudinal waves in gases, liquids and solid materials.
				9P.2.3.1.3	Explain how interference, resonance, refraction and reflection affect sound waves.
				9P.2.3.1.4	Describe the Doppler effect changes that occur in an observed sound as a result of the motion of a source of the sound relative to a receiver.

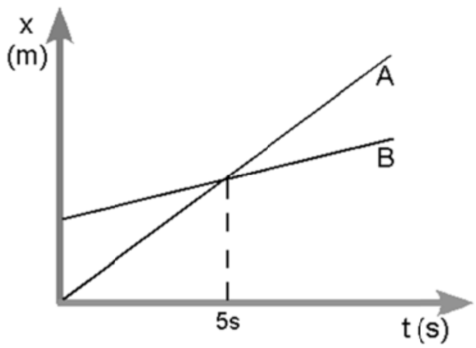
Minnesota Academic Standards in Science

	Strand	Substrand	Standard Understand that...	Code	Benchmark
P H Y S I C S	2. Physical Science	3. Energy	2. Electrons respond to electric fields and voltages by moving through electrical circuits and this motion generates magnetic fields.	9P.2.3.2.1	Explain why currents flow when free charges are placed in an electric field, and how that forms the basis for electric circuits.
				9P.2.3.2.2	Explain and calculate the relationship of current, voltage, resistance and power in series and parallel circuits. *For example:* Determine the voltage between two points in a series circuit with two resistors.
				9P.2.3.2.3	Describe how moving electric charges produce magnetic forces and moving magnets produce electric forces.
				9P.2.3.2.4	Use the interplay of electric and magnetic forces to explain how motors, generators, and transformers work.
			3. Magnetic and electric fields interact to produce electromagnetic waves.	9P.2.3.3.1	Describe the nature of the magnetic and electric fields in a propagating electromagnetic wave.
				9P.2.3.3.2	Explain and calculate how the speed of light and its wavelength change when the medium changes.
				9P.2.3.3.3	Explain the refraction and/or total internal reflection of light in transparent media, such as lenses and optical fibers.
				9P.2.3.3.4	Use properties of light, including reflection, refraction, interference, Doppler effect and the photoelectric effect, to explain phenomena and describe applications.
				9P.2.3.3.5	Compare the wave model and particle model in explaining properties of light.
				9P.2.3.3.6	Compare the wavelength, frequency and energy of waves in different regions of the electromagnetic spectrum and describe their applications.
			4. Heat energy is transferred between objects or regions that are at different temperatures by the processes of convection, conduction and radiation.	9P.2.3.4.1	Describe and calculate the quantity of heat transferred between solids and/or liquids, using specific heat, mass and change in temperature.
				9P.2.3.4.2	Explain the role of gravity, pressure and density in the convection of heat by a fluid.
				9P.2.3.4.3	Compare the rate at which objects at different temperatures will transfer thermal energy by electromagnetic radiation.

Appendix II – Modeling Instruction Curriculum Constant Velocity

CVPM - FP Worksheet 1

1. Consider the position vs. time graph below for cyclists A and B.



a. Do the cyclists start at the same point? How do you know? If not, which is ahead?

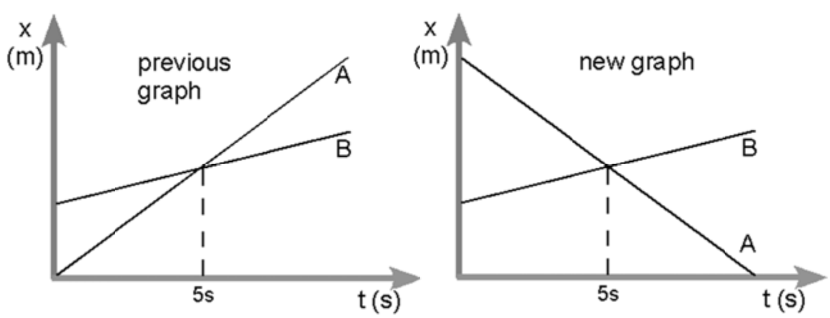
b. At t= 7s, which cyclist is ahead? How do you know?

c. Which cyclist is travelling faster at t = 3s? How do you know?

d. Are their velocities equal at any time? How do you know?

e. What is happening at the intersection of lines A and B?

2. Consider the new position vs. time graph below for cyclists A and B.

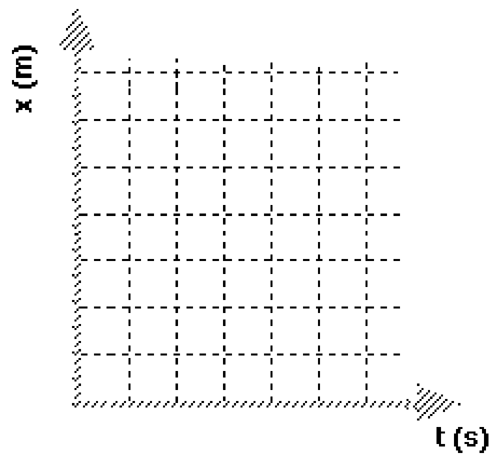


a. How does the motion of the cyclist A in the new graph compare to that of A in the previous graph from page one?
b. How does the motion of cyclist B in the new graph compare to that of B in the previous graph?
c. Which cyclist has the greater speed? How do you know?
d. Describe what is happening at the intersection of lines A and B.
e. Which cyclist traveled a greater distance during the first 5 seconds? How do you know?

CVPM – FP Worksheet 2

1. Robin, roller skating down a marked sidewalk, was observed to be at the following positions at the times listed below.

t (s)	x (m)
0.0	10.0
1.0	12.0
2.0	14.0
5.0	20.0
8.0	26.0
10.0	30.0



a. Plot a position vs. time graph for the skater.

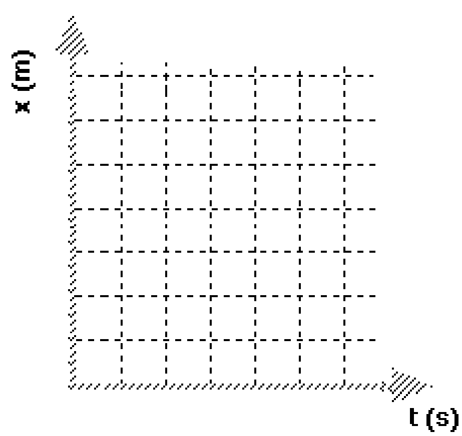
b. How far from the starting point was he at t = 6s? How do you know?

c. Write a mathematical model to describe the curve in (a).

d. Was his speed constant over the entire interval? How do you know?

2. The following data were obtained for a second trial

t (s)	x (m)
0.0	4.0
2.0	10.0
4.0	16.0
6.0	22.0
8.0	28.0
10.0	34.0



a. Plot the position vs. time graph for the skater.

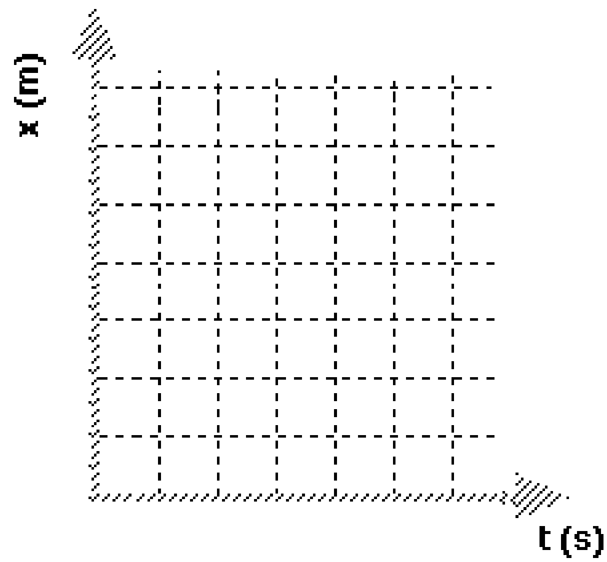
b. How far from the starting point was he at t = 5s? How do you know?

c. Was his speed constant? If so, what was it?

d. In the first trial the skater was further along at 2s than he was in the second trial. Does this mean that he was going faster? Explain your answer.

3. Suppose now that our skater was observed in a third trial. The following data were obtained:

t (s)	x (m)
0.0	0.0
2.0	6.0
4.0	12.0
6.0	12.0
8.0	8.0
10.0	4.0
12.0	0.0



a. Plot the position vs. time graph for the skater.

b. What do you think is happening during the time interval: t = 4s to t = 6s? How do you know?

c. What do you think is happening during the time interval: t = 6s to t = 12s? How do you know?

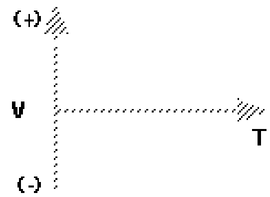
d. Determine the skater's average **speed** from t = 0s to t = 12s.

e. Determine the skater's average **velocity** from t = 0s to t = 12s.

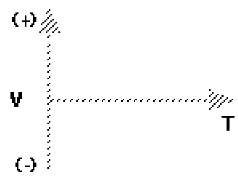
CVPM - FP Worksheet 3

Sketch velocity vs time graphs corresponding to the following descriptions of the motion of an object.

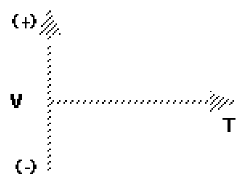
1. The object is moving away from the origin at a constant (steady) speed.



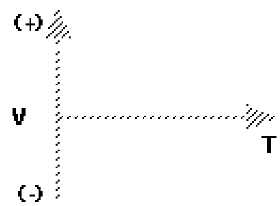
2. The object is standing still.



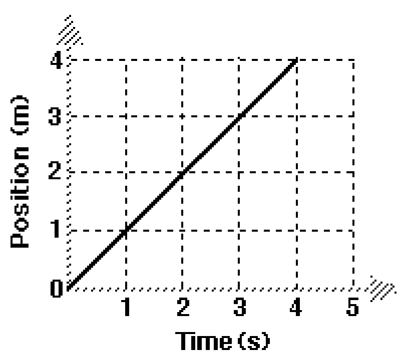
3. The object moves toward the origin at a steady speed for 10s, then stands still for 10s.

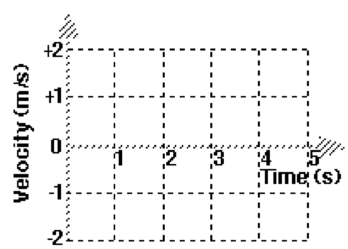


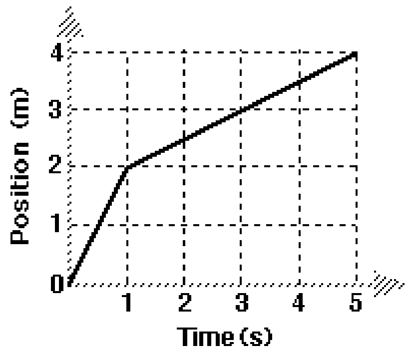
4. The object moves away from the origin at a steady speed for 10s, reverses direction and moves back toward the origin at the same speed.

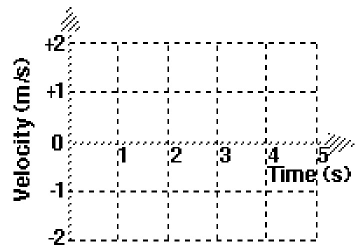


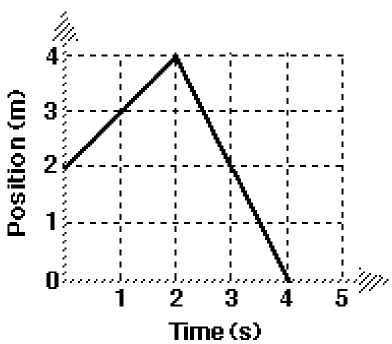
Draw the velocity vs time graphs for an object whose motion produced the position vs time graphs shown below at left.

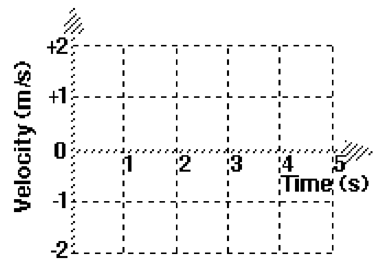




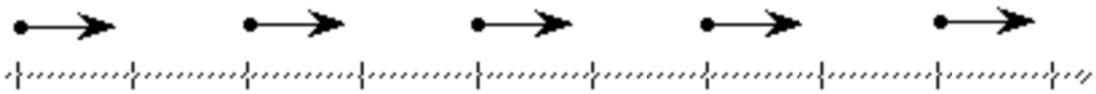

Position (m)
0
1
2
3
4
1 2 3 4 5
Time (s)


Velocity (m/s)
+2
+1
0
-1
-2
1 2 3 4 5
Time (s)


Position (m)
0
1
2
3
4
1 2 3 4 5
Time (s)


Velocity (m/s)
+2
+1
0
-1
-2
1 2 3 4 5
Time (s)

CVPM - FP Worksheet 4



1. From the motion map above, answer the following

   a. What can you conclude about the motion of the object?

   b. Draw a qualitative graphical representation of **x** vs **t** (see below).

   c. Draw a qualitative graphical representation of **v** vs **t** (see below).

   d. Write a mathematical expression that represents the relationship between **x** and **t**, from fig. 1.

   e. Write a mathematical expression that represents the relationship between **v** and **t**, from fig. 2

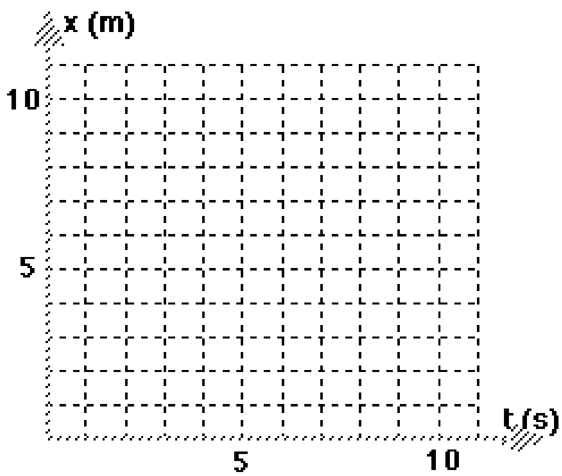
   f. Describe what the area under the curve in fig. 2 represents. Cross hatch this area.

2. From the position vs time data below, answer the following questions.

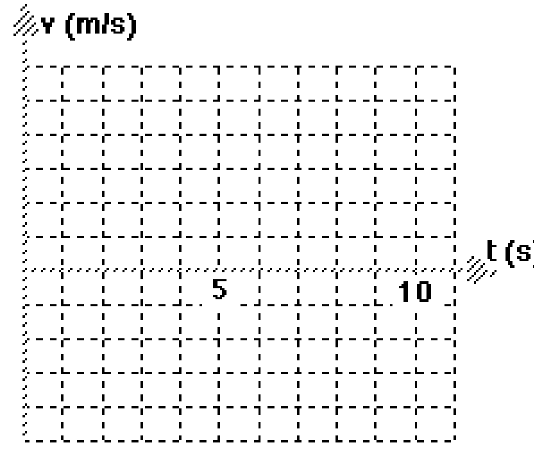
t (s)	x (m)
0	0
1	2
2	4
3	4
4	7
5	10
6	10
7	10
8	5
9	0

   a. Construct a graph of position vs time.

b. Construct a graph of velocity vs time.



(A)



(B)

c. Draw a motion map for the object.

d. Determine the displacement from t = 3.0s to 5.0s using graph B.

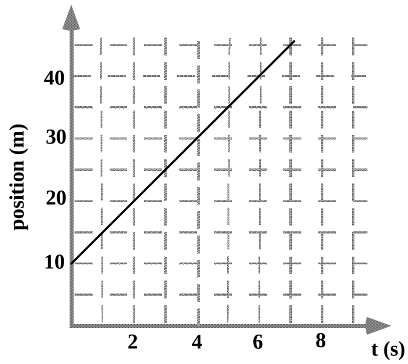
e. Determine the displacement from t = 7.0 s to 9.0 s using graph B.

Appendix III – Modeling Instruction Curriculum - Constant Velocity Quizzes

CVPM - FP Quiz 1

For all responses be sure to start by stating the basic equation used and to include units in your answers.

1. Use the graph below to answer the following:



a) Describe the motion of the object modeled in the graph.

b) Determine the object's average velocity (slope).

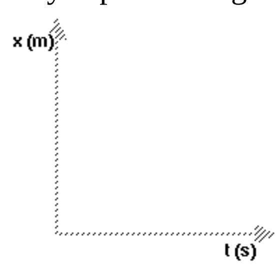
c) Write the mathematical equation that describes the object's motion. ($y = mx + b$)

d) Determine the object's position at t = 11 s.

Standard	Score
CV.2: I can interpret/draw position vs. time graphs for objects moving with constant velocity.	

I travel from Minneapolis to Chicago and back to Minneapolis. On my flight to Chicago I cover 300 miles in three hours. My flight home I had some wind with me and I was able to travel at 150 miles/hour. Draw a correct position vs time graph, and solve for the 4 unknown quantities with the correct units of my trip to Chicago and back.

Distance: _____________
Displacement: _________
Speed: _______________
Velocity: _____________

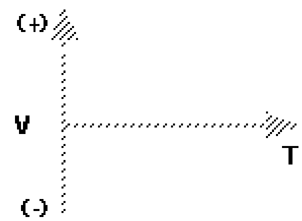


Standard	Score
CV.1: I know the difference between position, distance, displacement, speed and velocity	

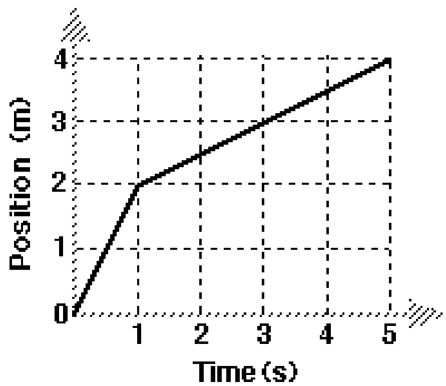
CVPM – FP Quiz 2

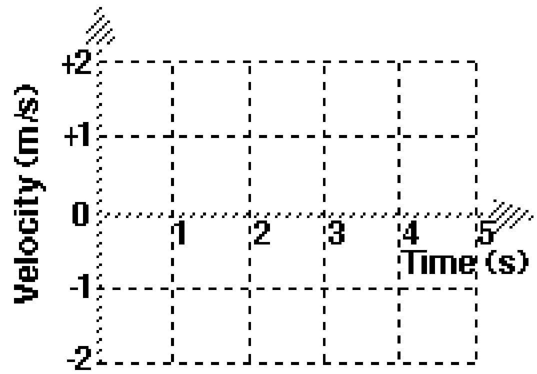
Draw the v vs. t graph for the following description

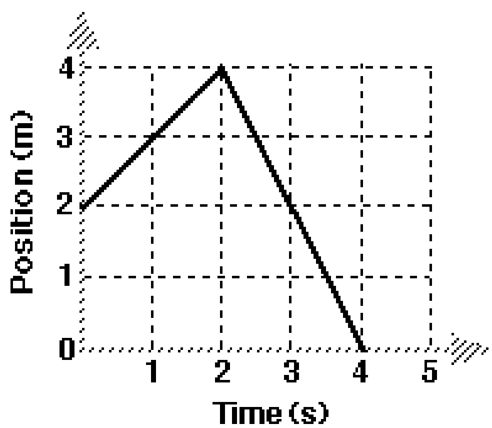
The object moves toward the origin at a steady speed for 10s, then stands still for 10s.

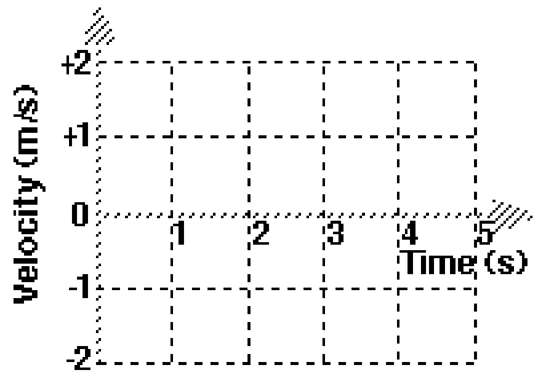


Draw the v vs. t graph for the following as well as a motion map, as well as the dot diagram









Standard	Score
CV.3 I can interpret/draw velocity vs. time graphs for objects moving with constant velocity.	

Appendix IV - Grade Data

Grading Scale: SBG

A	93.75
A-	87.5
B+	81.25
B	75
B-	68.75
C+	62.5
C	56.25
C-	50
D+	43.75
D	37.5
D-	31.25

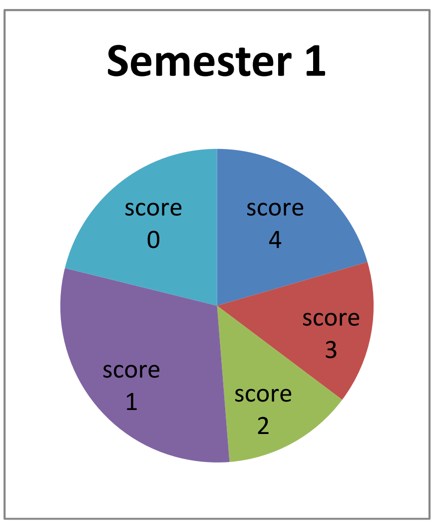
Grading Scale: Pre-SBG

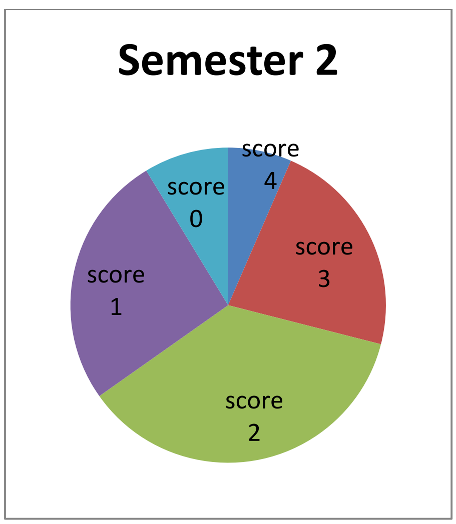
A	93
A-	90
B+	87
B	83
B-	80
C+	77
C	73
C-	70
D+	67
D	63
D-	60

Table 1: Constant Velocity pre-SBG compared to SBG

Class	Assignment 1 / CV.1	Assignment 2 / CV.2	Assignment 3 / CV.3	Grade	Test grade	Final grade
Pre-SBG	94%	82%	89%	88% B	45%	59% D
With SBG	1.99	1.82	1.81	46% D+	-	46% D+

Chart 1 and 2: Semester 1 and 2 Constant Velocity scores for standards 1-3 based on the number of students as well as on the average scores each one received with the three standards.





Percentages that correspond to the preceding charts:

Score	Semester 1	Semester 2
0	21.15 %	8.69 %
1	30.12 %	26.08 %
2	13.46 %	36.23 %
3	14.74 %	22.46 %
4	20.51 %	6.52 %

Table 2: Semester 1 and 2 Constant Velocity averages and percentages for standards 1-3.

	Semester 1	Semester 2	differences
Average CV.1	1.89	2.09	5.14 %
Average CV.2	1.97	1.67	8.36 %
Average CV.3	1.89	1.73	1.43 %
Standard Deviation	0.297	0.188	0.108
Number of Students	46	52	6.12 %

Table 3: Constant Velocity data pre-SBG

	Assignment 1	Assignment 2	Assignment 3	Test
Points out of	10	10	5	50
Average points of class	9.4	8.2	4.4	22.8
Average percentage of class	94	82	89	45

Bibliography

"American Modeling Teachers Association." (2013) *American Modeling Teachers Association*. AMTA, n.d. Web. 08 Oct. 2013. http://modelinginstruction.org/

Clark, Don. (2013) “Bloom’s Taxonomy of Learning Domains” Web. 15 Dec. 2013. http://www.nwlink.com/~donclark/hrd/bloom.html

Deddeh, Heather, Erin Main, and Sharon Ratzlaff Fulkerson. (2010) “Eight Steps to Meaningful Grading.” Kaplan 91.7: 53-58. pdkinti.org

Guskey, Thomas R. (2000) "Grading Policies that Work Against Standards.....and How to Fix Them." *NASSP Bullentin* 84.620: 20-27.

Guskey, Thomas R. (2004) "0 Alternatives."*Principal Leadership* 5.2: 49-53.

Hestenes, David. (2000) “FINDINGS of the Modeling Workshop Project (1994-2000).” Arizona State University. http://modeling.la.asu.edu.

Jackson, Jane, Larry Dukerich, and David Hestenes. (2008) "Modeling Instruction: An Effective Model for Science Education." *Science Educator* 17.1: 10-17.

Modeling Instruction – Legacy Site. Arizona State University. http://modeling.asu.edu/

O'Connor, Ken. (2011) *A Repair Kit for Grading 15 fixes for Broken Grades*. 2007. Reprint. Boston: Pearson 2011.

Oliver, Bruce. (2011) "Making the Case for Standards-Based Grading | Essential Educator." *Essential Educator | Where all educators are special*. Essential Educator, 11 Mar. 2011. Web. 25 Jan. 2013. <http://essentialeducator.org/?p=3415>.

Reeves, Douglas B. (2007) *Ahead of the curve: the power of assessment to transform teaching and learning*. Bloomington, IN: Solution Tree.

Scriffiny, Patricia L. (2008) "Seven Reasons for Standards-Based Grading." *Education Leadership* 66.2: 70-74.