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Development of a standards-based classroom for high school physics at Solon Community School District

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Chapter 3: Development of Standards-Based Classroom

Abstract

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Chapter 1: Introduction

The current emphasis in K-12 schools is largely on student achievement (No Child Left Behind [NCLB], 2002). This focus has led to the development of a variety of approaches in curriculum, instruction and assessment each designed to increase student achievement.

Regionally, as well as, nationally student achievement has been measured by standardized testing. This places pressure on districts and ultimately classroom teachers to align curriculum scope and sequence with national mandates, as well as differentiate instruction in order to meet student needs. Finally, assessments need to also align with standards so teachers can see where more instruction is needed to prepare students. As the legislature approves new national standards for k-12 science education and standardized testing continues to be utilized both for high school and career proficiencies, it should be no surprise that standards-based systems have entered the grading conversation. "...Educators face the daunting task of how best to grade and report student learning in terms of those standards" (Guskey, 2001). One approach that combines curriculum, instruction and assessment is standards based grading.

What is Standards-Based Grading?

Standards-Based Grading (SBG) is a method used to measure and report student mastery of specific academic standards or learning goals (Iamarino, 2014). It communicates both students' strengths and weaknesses for each of the big ideas by organizing content in the gradebook by standards, with each standard falling under broad goal categories. Examples of standard categories are 'Chemical Reactions', 'Newton's Third Law' or 'Photosynthesis' rather than the more traditional labels of 'Chapter 3' or 'Unit 5'.

Only standards are listed in the gradebook and they directly show student performance on core concepts. Students are encouraged, with SBG, to take ownership of their education. Reflection, review, and revision of their original work may lead to a new score representing a new level of mastery for each standard. Redos and retakes of both practice and assessments are allowed and at times required (O'Connor, 2017). The possibility of learning more, demonstrating growth and being rewarded for it is always available.

What is the Purpose of Standards-Based Grading?

The use of specific standards to describe desired learnings; first to the students themselves, then to their parents and other stakeholders, is crucial to intelligible reporting of academic progress (O'Connor, 2017). The result is grades that more clearly and accurately show a student's learning progress toward the big ideas of a course. This approach serves two goals: one is to communicate valid information efficiently to external stakeholders like universities, employers, and parents. The second goal is to motivate students to persist in their personal learning of course objectives, knowing they can always raise a grade with evidence of a higher level of understanding.

Why is Standards-Based Grading Important to Stakeholders?

In order to consider the reason why standards-based grading is important one should consider again the intended purposes of grades: to communicate and motivate. In the next paragraphs, the purpose of grades will be described for several audiences: post-secondary, students, parents, and educators.

Grades should have meaning for post-secondary. When a prospective employer or admissions representative looks at an "A" grade, what does it mean? Does it tell him or her clearly that the student has cognitive understanding and appropriate skills in the area listed or that the student is an extremely hard worker and functions well with others? What does a business owner want to know about a prospective employee? Likely all of these aspects, but grades, as we have known them, blend these academic abilities with character traits and stakeholders are left to guess which is true of the student (Guskey, 2006).

Consider the following possibilities of an "A" grade:

i→ Billy consistently performs very well on all or most of the big ideas in class.

ii→ Jack clearly missed some critical connections, but did three extra credit projects.

iii→ Steve struggles in class, but he is a nice boy and completes all of his homework.

Now consider these "D" grades...

i→ Beth regularly mis-applies key concepts of the course.

ii→ Sue normally performs very well, but her mom was in the hospital the night before a large test and she bombed it and forgot to turn in the homework due.

iii→ Katie is natural in school and aces tests. Since she doesn't need practice she does none of the graded homework.

All but two of these grades communicate an inaccurate representation of the student's true academic understanding. The meaning is lost if it a grade is not honest and accurate. Standards-based grading establishes clear concepts that the grade is referenced to (Iamarino, 2014; O'Connor, 2017). In other words, a grade should have communication value. In the next paragraph, the meaning of grades for students will be described.

Grades should have meaning for students. Grades now have practical meaning for students as well. Standards-based grades help students "know what they don't know". In more traditional grading systems, if a student missed three points on a 30-point test he or she was happy and did not question much about what ideas were missed and why those questions were missed. Instead he or she simply thinks--“A” is good right? With standards-based grades, if all three missed questions were on ideas related to density, the student has not yet demonstrated understanding of the density standard and the recorded score is low. Not only is he or she clearly made aware of a specific area for improvement, but also motivated to continue learning to improve this standard score.

Traditional grading systems are designed for sorting students whereas standards-based grading is designed to help all students learn at high levels (O’Connor, 2017). Sometimes kids are irresponsible, or unready at the time we meet them. Learners often mature as they grow older and gain more experience. In standards-based grading a student can redo homework (practice) or assessments and if he or she needs to show a higher level of understanding, the new score replaces the old one (Townsley, 2013). The student is always given the chance to learn more, learn better and be rewarded. In other words, a grade should have motivational value. In the next paragraph, the meaning of grades for parents will be described.

Grades should have meaning for parents. Standards-based grading provides improved information for parents. Parents are interested in what exactly their children are learning in classrooms each day. They desire to know more than just category headings like “Tests, Quizzes, and Homework”. They want to see the skills and understandings that are being taught and how well their sons and daughters understand those targets (Guskey, Swan & Jung, 2012). Standards-based grading clearly identifies topics that are addressed and then communicates clearly whether each learning target is a strength or weakness of each student. If two standards record low scores, then parents know exactly where to point their student to focus attention. Conversely if a standard score is exceptional then parents can also see areas of ability or aptitude for their child.

Grades based on student performance of set standards rather than resulting from a mix of academic, behavior, and practice performances not only communicates more clearly to those observing the gradebook, but also adds clarity for teachers entering learning targets (Guskey, Swan & Jung, 2012). In the next paragraph, the meaning of grades for teachers will be described.

Grades should have meaning for teachers. Standards-based grading provides information to the teacher as well. When the results of a formative assessment are in, teachers can look at the data and see clearly what standards students clearly got and what ones they struggled with. Standards-based grading illustrates what students know already and what they still need to learn (O'Connor & Wormeli, 2011; Townsley, 2013). Using this information, teachers can adjust instruction accordingly. If a student is ready to advance, he or she can be moved to enrichment activities, if not ready he or she can be engaged with feedback and reteaching. This process helps teachers help students and more learning is the result. This process is of course, scaleable to reteach or enrich an entire class.

Teachers also use standards-based grading data to make targeted long-term adjustments to their curriculum and instruction. They may prioritize the amount of time spent on a standard from consistent inaccurate student preconceptions or de-emphasize a particular concept as a result of student performance on formative assessments. In addition, instructors may allow more authentic practice and/or assessments that still target given course standards. Standards-based grading data reveals patterns that teachers can use to identify the unique needs of students. (Iamarino, 2014).

In summary, standards-based grading is important to the variety of stakeholders because it provides a structure for continual deep learning of specific measureable knowledge and skills and communicates timely a clear and accurate level of cognitive understanding separate from behavior.

The Problem of Practice

The problem of practice that will be investigated in this paper is "How do teachers effectively communicate learning progress and promote continued growth in a high school physics classroom using standards-based grading?" As physics teachers consider best practices in their classroom, a practical look at the transition to standards-based grading is needed. Similarly, protocols and samples included in this paper can be helpful for teachers who are unsure of a standards-based grading starting point.

Just as there are a variety of structures to any assessment strategy, this paper will be helpful, not only to teachers new to standards-based grading, but also to those who have already implemented SBG into their personal practice. I will be sharing my personal journey, as well as our local districts' background in an effort to provide suggestions on successfully implementing this system at both the classroom and district levels.

This paper will include a review of the literature including a historical look at grading practices, a description of the major components of standards-based grading, the effectiveness of standards-based grading, and successful implementation of SBG at the building level. The paper will end by sharing my personal reflections on the benefits, challenges, and tradeoffs of establishing a standards-based grading physics classroom and my personal next steps in further developing my grading practices.

Chapter 2: Literature Review

This literature review will describe the historical aspect of grading, a description of the major components of standards-based grading, effectiveness of standards-based grading, and successful implementation of standards-based grading at the classroom level. Throughout this literature review, the strengths of standards-based grading as a communication tool for learning will be highlighted. Finally, a focus on the role of the teacher within the literature will be documented in this section.

History of Grading in America

The historical path of standards-based grading has been guided by its evolving purposes. Students were initially sorted or tracked by schools using grades to communicate proper occupations. Communication and motivation have been primary themes throughout the history of American grading practices. In the next paragraphs, the history and purpose of grading will be described.

The changing purpose of grades throughout time. Grades…'the language of school' are a mainstay of the American educational experience. Yet they have not always looked the same, nor have they always served the same purpose. It is well worth a look at where we have been in our grading practices, if we are to more fully comprehend their necessity, usefulness, and potential (Scheider & Hutt, 2013). There has always existed a core tension in the purpose of grading in the United States between what promotes systems and what promotes learning (Schneider & Hutt, 2013). External communication with stakeholders (parents, other schools, universities, and employers) promotes an organized system; whereas internal communication of grades can be used as a pedagogical tool to motivate student learning. The challenge is that both have significant value and benefit. Grades are essential for building an efficient and effective school system through organization and communication outside of school; teachers with parents and school districts with legislators, employers, and college admissions offices. Grades can also serve a pedagogical purpose inside school walls by motivating students to work hard and learn more. Both of these critical aspects, organization and pedagogy, have had major influences on grading system variations in America. Additionally, schools have worked to become more standardized in their grading practices. In the next several pages I will dig deeper into the literature related to the origins of American grading.

A look back at the roots of grades. Late in the 18th century, grades were thought to be the key to student motivation in British schools. Given the mass migrations from England to America at the time, it is not surprising that this idea also migrated into America. Competing with peers for class rank or class honors, and even financial rewards can be traced directly to European education systems. For example, the winners of the Cambridge Mathematical Tripos (a multi-day examination tournament beginning around 1780) with pre-seeding and daily re-seeding received a life long endowment in addition to academic status (Schneider & Hutt, 2013). Urban American schools, early in the 19th century, used a similar model of daily examinations and movement to or from the front of the class. More advanced students taught less advanced ones; believing that if you teach, you learn. Though related to European systems, this model with its frequent opportunities to “reassess” and fluidity of ranking was uniquely American in its adaptations (Schneider & Hutt, 2013). Still, the direct and daily competition seemed antidemocratic to many. Policy makers were concerned that constant testing and ranking promoted a sort of immediacy of performance rather than on-going cognitive and moral development (Schneider & Hutt, 2013). Another limitation was that this type of constant ranking was only local and in turn did not communicate a true level of understanding to those outside of the school. “The solution to this problem, according to [Horace] Mann, was not only to transform schools from one giant competition into a series of graded steps, but also to substitute the public quizzes and frequent re-ranking with written examinations and a series of monthly report cards” (Schneider & Hutt 2013, p. 6). Mann promoted age-grouping students for lectures, allowing movement up at his/her own pace, and utilizing a periodic (monthly) report card that recorded success over time. Another reason Mann advocated for this system was because rural schools in America had irregular attendance, multi-age groups, and no common texts to work from. Replicated from Prussian schools, this model was received as more pedagogically cooperative with an intrinsic motivation, as well as organizationally efficient.

By mid 18^{th} century, according to Labaree 1988; Steffes 2012; and Tyack 1977 (as cited in Schneider & Hutt, 2013, p. 7) “educational enrollments were expanding rapidly...the product of compulsory school enforcement, child labor laws, and the growing use of education as a tool for social mobility.” As a result of this dramatic growth, individualized reports became less sustainable, yet the need for communicating student abilities was even more important as more students moved from grammar to high school and on to college. Traditionally colleges used entrance exams given by individual professors to admit or deny students, but this process was too subjective and effort intensive to maintain. Colleges eventually moved to accredit area high schools based on their curricula, but this was limited as reviews were regional only. The upward mobility of Americans and resulting need to systematically track students vertically on a larger scale was apparent, not to mention horizontal mobility from school to school was increasing nationally as well. Grades, then, held the potential to be a universal way to evaluate and communicate student achievement across the nation.

Even though grades became a consistent part of American education early on; how grades were represented and communicated was not. According to Mary Lovett Smallwood, (as cited in Durm, 1993) students were first sorted using grades at Yale, as found in the footnotes of then President Stiles' 1785 diary. Smallwood also credits Yale, for being the first to create a numeric grade scale in 1813. Their four point scale was likely the origin of the "4.0" college system of grading today, though there was no connection to letter grading at that time. Soon after this William and Mary's 1817 faculty reports classified students using 4 categories of descriptive adjectives… "No.1. The first in their respective classes; No.2. Orderly, correct, and attentive; No.3. They have made very little improvement; No.4. They have learnt little or nothing." Many years later, in 1883, the first use of a letter grade can be found in a reference to a "B" at Harvard. Eventually all of these representations came together in 1897 when Mt. Holyoke implemented an A-E letter system including descriptors and percentage levels as well. "Therefore what Mt. Holyoke adopted in 1897 became the cornerstone for college grading" (Durm, 1993 p. 3). With a small change the following year to include the "F" it could also be argued this became the model for high school grading as well.

Even with this systematic culmination in marking scheme, inconsistencies permeated grading systems as different scales, some including and some excluding behavior, as well as differing reporting periods were utilized. Sometimes numbers or descriptors; other times percentages or letters were used to represent achieved levels of learning as education institutions fumbled to calibrate their grading systems. The chosen model varied from year to year and university to university, even from college to college within the same university! Although John Dewey's laboratory school in the 1890s was student centered, the tradition of schooling across the country was "gradedness," and it became unyielding (Anderson, 1992). Dewey's example suggests high schools continued to struggle with the best way to approach and report learning, even one hundred years later.

This grading system, while having individual variations in percentages for each letter grade, has essentially gone unchanged since the 1890s and remains the standard by which most colleges and high schools gauge learning in each and every student. This grading system motivates students without creating excessive competition, tracks student progress and communicates accurate individual performance to parents, colleges and employers. The current system of traditional grading, though not without flaws, is universal and scalable nationally. In the next section, the major components of standards-based grading, an improvement on traditional grading practices, will be described.

The Emergence of Standards-based Grading

Even after multiple changes through the years in grading systems, big challenges persisted which hindered the effectiveness of each iteration. Three crucial hurdles stand out. First, vagueness in reporting the actual curriculum instructed and assessed. Second, inaccuracy representing student understanding of course material. Third, fixed & punitive mindset toward instruction and assessment. There existed a clear need for standards-based grading. Standards-based grading identifies specific, measureable concepts as learning targets communicated to stakeholders. Standards-based grading does not blend work habits, homework, nor extra credit into its communication of student understanding. Such factors skew grades artificially, often inflating and sometimes deflating overall scores. Standards-based grading is all about student growth. It has been called 'formative assessment' as a whole because of its ongoing process of feedback, reteaching and reassessment--instead of locking down any single poor performance in the gradebook.

Growing out of the roots of historical grading in this country, standards-based grading is a strong step for improving curriculum, instruction, assessment and ultimately student-learning in American education.

Major Components of Standards-Based Grading

Standards-based grading has five major components. In standards-based grading, teachers must identify the big ideas or standards that students must learn. The next component of standards-based grading is separating proficiency from work habits. In addition, standards-based grading involves eliminating extra credit. Next, students are provided multiple opportunities to demonstrate their understanding. Finally in standards-based grading, homework is considered practice and does not count towards the final grade. In the next paragraphs, each component will be described in detail.

Identifying the big ideas (standards). Standards-based grading measures and reports student mastery of specific academic standards or learning goals. It communicates both student strengths and weaknesses in understanding the big ideas of a course by organizing content in the gradebook by key targets for learning or standards. For example, in standards- based grading descriptive titles, based on the targeted standards such as 'Vectors', 'Newton's Third Law' or 'Momentum', are used in the grading system rather than 'Chapter 3 Quiz' or 'Unit 5 Test'. These 'top-level' standards can be called "power" standards as they are at the big idea/breadth level. Under these, one could describe finer levels of detail about the learning expected if desired. Standards found in the gradebook are typically based on state and/or national standards for a given discipline and focus solely on academic performance. This means that including components in the grading system related to classroom behavior/work ethic, cannot be part of a student's course grade. The rationale for narrowing the focus of grades and separating academics from practice or behavior is to provide truer data reflective of actual student understanding of the target concepts to those viewing the scores. The belief is that more valid grades will provide more valuable information about what students actually understand to students, parents, and teachers. Grades, based on specific standards, more clearly communicate student-learning & current understanding of specific course concepts (Crawford, 2011).

Standards help guide student learning. Standards-based grading reveals both areas of strong aptitude and gaps in understanding. Students readily self-identify areas of capacity and areas in need of improvement. Knowing one's strengths, as well as weaknesses is crucial in filling in gaps to promote learning. Standards-based grading transfers ownership of learning back to the student because they now know on which standards they have either a proficiency or mastery and those with which they need more practice (O'Connor & Wormeli, 2011). Today internet-based gradebooks give students 24/7 access to their standing in a course (their learning progress). Each student can not only identify an area of weakness, but also go deeper seeing specific skills involved in that standard written in student-friendly language. Knowing these concepts a student can review class materials that taught those abilities, ask for more practice sheets, research sources for review, set up a conference with the teacher to relearn.

Standards help guide teacher instruction. Establishing standards helps guide instruction by defining learning to be within set standards and in doing so limiting 'fluff' activities that may be included for engagement purposes, but not focused on key learnings. Each day a learning goal(s) is established and clearly communicated to students typically on the classroom whiteboard. This helps the teacher communicate a clear learning focus of the day to students (Crawford, 2011). It also provides the teacher with an outline for the class period. Having learning goals posted helps to ensure lessons remain focused on the purpose of a particular lab or activity, as opposed to just doing an activity. Depending on the difficulty of a target concept and the breadth of a goal, the focus can remain the same for several days, even while separate activities and strategies are taking place. This frees a teacher to structure lessons in an order that best builds student cognition versus following a preset curriculum. Finally, teachers gain a better sense of whether or not an activity is worthwhile, by comparing the resulting learning versus the lesson goals (Crawford, 2011).

Standards help guide parent connection. Students, teachers and even parents are empowered by a standards-based classroom. Student language is not the same as teacher language so when parents are able to better see, (more directly from the teacher) what concepts are taught they have a better understanding of what their children are learning in class. Parents can now compare how the scope of concepts (standards) is similar to other schools, and can make their own determination as to whether their children are prepared for future goals. This targeted information on areas of strength can help parents to guide their children into unrecognized areas of passion and capacity. Information on areas of weakness can provide parents with the information they need to encourage their children to develop personal initiative and perseverance. Given the extra information standards-based grading provides, parents can connect with their kids regarding academic performance as well as the practice needed to result in a successful performance and how this relates to the post-secondary world. In summary, the first major component of standards-based grading is identifying the standards, the big ideas that all students should learn, and communicating them to students and parents.

Separating academic proficiency from work habits/behaviors. The second component of standards-based grading is separating proficiency from work habits. Inconsistencies in grading practices have led many to perceive the act of grading as highly subjective and often unfair to students (Guskey & Jung, 2012). Teachers constantly debate what should be included in a grade. Content proficiency is a focus of today's schools, yet many educators feel this is not enough to tell the whole story of a student's learning experience. Many instructors believe effort and active participation should figure into grades. However, mixing criteria such as academic mastery with character habits creates a hodgepodge grade (Cross & Frary, 1999) that ranges from confusing at best to meaningless for all practical purposes. The traditional gradebook does not clearly separate academic performance from work habits. Because of this blended communication, parents struggle to know whether their child understands the material well or is simply compliant with homework completion and actively participates in class discussions. Students are often unable to identify specific areas in which they need improvement. A low score in "Unit 3" may mean that the understanding of Newton's 2nd Law is incomplete or it may mean that understanding is accurate, but homework was not completed or that the student wasted class time. Another more meaningful approach is to offer separate grades for product, process, and progress learning criteria (Guskey, 2006; Guskey & Bailey, 2010). In summary, separating proficiency from work habits is an essential component of standards-based grading.

Homework/practice does not count towards the final grade. The third component of standards-based grading is establishing homework as opportunities to practice and as such homework is not graded. Homework is a valuable part of the learning process...but it is a work habit, not an academic mark. Educators utilize the process of daily work for a variety of reasons including instilling responsibility and encouraging work ethic, but neither of these represents the real purpose of homework. Homework's purpose is to help students practice in order to reach learning goals, not to raise scores (Christoper, 2007). If homework is included in the course grade, then this is communicating (intentionally or not) that one of its purposes is to influence or raise grades. For this reason, homework should not count in the gradebook. If instead, homework was eliminated from the gradebook, yet still checked for accuracy, quality feedback was still provided for improvement and interventions were still applied if it was not attempted or not completed, then homework would fulfill its true purpose of increasing student learning.

Students have the opportunity to 'try before you buy' with homework. They are allowed multiple opportunities to practice a concept and to receive feedback, encouraging real learning before any assessment is done and entered in the gradebook (Vatterott, 2011). Homework is formative, meaning it takes place during the learning process, while conceptual understanding and mental models are being developed. When homework does not count towards the grade, it is considered to be assessment FOR learning (Stiggins, 2005), where students work out problems building an experience basis so authentic test problems can be successfully solved drawing upon the new mental models built from working with practice problems. This is opposed to problems given students at the end of unit in the form of a test, which is a summative in nature. This assessment OF learning takes a snapshot of where a student is at in the learning process (Christopher, 2007).

Homework is valuable for teachers in reaching learning targets. Teachers gain insight into student misconceptions/preconceptions through student practice (aka homework) and can then use that information to adjust curriculum to meet individual and class needs. Teachers also diagnose gaps in understanding and differentiate instruction through re-teaching or enrichment to maximize the learning of individual students, and can minimize repetition in the classroom by analyzing homework successes and failures.

Teachers often grade homework for fear that students won't do it, yet other classroom tasks such as debates and note-taking are often ungraded yet students still complete them. The activities of discussion or debate are merely expected and this should be true for homework as well. Homework could be put to students as an engaging challenge that increases understanding as opposed to a boring, valueless hoop to jump through (Vatterott, 2011). Grades become more meaningful when separate grades are assigned for each category and extra credit is eliminated (Munoz, Guskey, 2015). In summary, the third major component of standards-based grading is that homework or practice while learning the big ideas should not count toward representing a student's understanding of the standards.

No extra credit is allowed. The fourth component of standards-based grading is not allowing extra credit to be a part of the grade. Removing extra credit clarifies the meaning of a grade to represent only the understanding or skill a student has rather than the effort or income that he or she possesses or has exerted. Standards-based grades are determined exclusively by students' demonstrated mastery of standards and benchmarks, making them more accurate than grades based on traditional grading systems that have incorporated a mixture of academic performance, extra credit, behavior, and work habits. (Proulx, Spencer-May, & Westerberg, 2012)

Standards based grading is often paired with reassessment, the opportunity to redo assessments. Extra opportunity, not extra credit, encourages students to focus on core course ideas and motivates them to persevere with practice. Not all students learn on the same timeline and educators need to value what students learn over when (Townsley, 2013). To conclude, the fourth major component of standards-based grading is to not allow any form of extra credit in a grade inaccurately representing student-learning levels. In the next section I will expand on the idea of reassessment and multiple opportunities to show proficiency.

Multiple opportunities are allowed to demonstrate learning. The fifth major component of standards-based grading is allowing multiple opportunities to demonstrate learning. The American education model is outdated, often requiring a one-size fits all, learn exactly the same things at the same times method. This is not in-line with learning theory where students learn at different paces and in different ways (Wormeli, 2011). We also know that misconceptions need to be confronted repeatedly in order to scaffold new and re-scaffold existing mental models. This takes time and numerous efforts in order to assimilate new cognition. We carry forward concepts and skills we encounter repeatedly, and we get better at retrieving them the more we experience them…. We improve with practice, descriptive feedback, and revising our practices in light of that feedback, followed by more practice, feedback, and revision. It's the way authors write great books; it's the way scientists discover; it's the way machinists solve problems (Wormeli, 2011).

In a traditional grading system, if a student misses a deadline, they are not allowed to continue learning or allowed only partial credit when they finish a paper, project, or redo a test. At this point they often disengage. Standards based grading allows for immature acts by rewarding full credit for full mastery at any time (Iamarino, 2014;

Townsley, 2013). This maintains hope for learning at any point in the course. Making students redo their learning until it meets high expectations demands far more of both students and teachers than letting them take a failing grade—but it also results in far more learning (Wormeli, 2011).

Accuracy is also increased by basing grades on what students know and can do at the end of instruction, rather than on an average of what they knew (or what they didn't know] at various points during the learning sequence (Proulx, Spencer-May, and Westerberg, 2012). Wormeli (2011) tells of an Olympic sprinter experience and how one or more poor performances don't limit his/her future achievement. When students get multiple opportunities to assess their understanding of a standard, it makes sense to emphasize the most recent performance. Just like a runner, one bad race should not limit the possibility of winning...or in the case of education, earning mastery (aka an "A"). It would be ridiculous to tell an athlete that he could not qualify for the team because of two poor performances. Maybe he was wrestling with a cold at the time or family stress, etc, etc. Regardless, he (as well as our students) should be allowed to prove mastery at each performance, free from the burden of past hiccups. This is not to say that extra training or additional practice may be desired or even required to be allowed a new assessment. It should be noted that performance is not guaranteed to increase with each attempt. Performance may go up or down depending on the current understanding students have at that time, but growth is always the goal. There is tremendous value in not limiting a student's potential (punishing) for making mistakes while learning, even if the mistakes are not just in misunderstandings, but also in poor behaviors (Proulx, Spencer-May, and Westerberg, 2012). Now that five major components of standards-based grading have been identified and discussed, the effectiveness of standards-based grading in real school districts will be described.

Effectiveness of Standards-Based Grading

Elementary school examples. Pressure to increase student achievement persists in American schools. In this subsection I will summarize several studies that researched the efficacy of standards-based grading and standards-based report cards in efforts to raise academic performance in elementary school systems. The systems range from rural to urban districts.

Buttery (2014) studied state test scores from a rural Kentucky school. She found a large increase in state math test scores of students using a standards-based grading versus students who were not. Language arts scores were also higher though only slightly. While Buttery's study was limited to a rural school, Welsch (2013) compared grades earned in classrooms all across the United States. Though this study was broad, it's research focal point looked at specific state aligned standards-based grading in reference to corresponding state standardized test scores and found a modest connection between the two.

Report card organization and communicating data in general is a key point in the standards-based grading movement. Rose Prejean-Harris (2013) wanted to know if the type of report card could influence the performance level on standardized math and science test score of 3rd graders. She compared student performance in standards-based vs. traditional graded classrooms. Her results did not find a statistically significant difference between the two. Like Prejean-Harris, Hardegree (2012) gathered data from Georgia school districts, but unlike her, Hardegree determined that there is a significant relationship between a standards-based report card (SBRC) and Criterion Referenced Competency Tests (CRCT). This means that the student-performance levels reported by the teacher on the report card were consistent with the resulting scores of standardized test in reading and math. One notable exception was students with free/reduced lunch status earning the same standards-based grade scored lower on the standardized tests than students who were not.

Though the research is not very deep regarding standards based grading in elementary schools, the practice has been in existence in this education setting much longer than it has in secondary schools. The following subsection continues an analysis of standards-based grading efficacy, moving from elementary to secondary schools.

Secondary school examples. While the purpose and organization of report cards are different in an elementary versus secondary school setting, accurate communication with stakeholders remains a central purpose and equally if not more important here.

The first study by Haptonstall (2010), explored the correlation between the grades of middle school students in standards-based classrooms compared to traditional classrooms and their scores on the Colorado Student Assessment Program. While all districts involved (both grading styles) showed a correlation between grades and test scores, one district in particular that utilized standards-based grading showed a higher correlation and higher grades than the others.

Moving up the age scale to high school, two studies for math were considered. Rosales (2013) compared end of course test scores in algebra 2 classrooms. Even though she did not find a statistically significant score difference between traditionally-graded students and standards based students, she did note improved communication and new learning methods for students were valuable effects of implementing standards-based grading. In contrast, Pollio's (2015) examination of algebra 2 grades to state test scores showed that test pass rates doubled for those in standards-based classrooms. Her data also indicated more valid assessment of at-risk students using standards-based grading. This accuracy-proven representation of student performance bodes well for identifying and closing learning gaps. Finally, Iverson (2014) looked at end of course grades in a traditional grading school and a standards-based grading school as compared to scores on the Iowa assessment subtests of math and English. In this study, there was a significantly stronger relationship in most all demographics of students in both areas for standards-based schools.

It appears that even though standards-based grading can be successful in both settings, secondary schools may enjoy more academic benefit from the practice. I would contend that with increased metacognitive skills, secondary students can advocate for themselves much better than elementary students in SBG systems. Many schools across the country have embraced standards-based grading not only for increased student achievement, but also for the improved communication with stakeholders. The next section summarizes key aspects toward successful implementation of the practice.

Successful Implementation of Standards-Based Grading

This section will outline examples of successful implementation of standards-based grading. The success or failure of educational initiatives can be viewed through the resulting student achievement data, as well as, the culture of learning and communication that follows implementation. Several school districts' standards-based grading journeys will be described.

Minnetonka, Minnesota school district leaders studied grading practices for years. During that time they confronted the following two questions dealing with grading practices, What goes into a grade? And how do we report it? (Erickson, 2010). They came to the conclusion that a grade must include student knowledge and skills only and not behaviors. Educators here also felt strongly that grades must provide a path to success and not harm a student. As a result of their work, additional district policies that joined behaviors to grades were revisited and altered. Attendance and cheating were disconnected from having severe negative effects on grades. More immediate and growth related consequences were implemented in their stead. Executing this initiative continues as they realized how it has improved education throughout the district. Student performance (more grades of B & C) and attendance (59% higher) both improved following the changes. Though these grades tightened the bell curve up (less low and less high scores), the overall mean was higher.

Omaha schools had a similar positive performance shift when they implemented standards-based grading in high schools. The goals were to increase student achievement, stakeholder communication, and classroom consistency (Proulx, Spencer-May & Westerberg, 2012). The plan held big challenges for a large district. Moving grades away from a reward/punishment structure toward an evidence-based format and shifting to a 'Less is more' curriculum philosophy district-wide are not small tasks. In the end, results were positive with frequent community conversations about higher cognitive achievement, as well as actual achievement growth with less grades of F & Ds and more B & Cs.

In Kentucky, a collaboration of teachers, educational leaders and educational researchers worked on developing a standards-based grading report card (Guskey, Swan & Jung, 2011). Their goal was to develop a system to communicate performance on set criteria and separated academic readiness from work habits. Following preliminary parent surveys the group created a form that displayed both product and process data for each student, as well as the rubrics used. They limited the reported standards to six from feedback that indicated any more would be overwhelming. In addition, a section that combined general information about each course with individual student suggestions for improvement was included. The clear majority of teachers said the standards-based report card provided better and clearer information than traditional report cards. Parents preferred the new 'easy to understand' format as well. More teachers and schools were added the next year and full, statewide implementation was targeted for 3-5 years.

The effectiveness of standards-based grading is described through student achievement scores as well as the actual implementation process by schools. In the previous sections, the effectiveness of standards-based grading as measured by standardized test scores was mixed. Some studies said standards based grading had negligible benefit, while others said the practice was key to student success. In general, these schools created multiple year processes in order to implement standards-based grading practices. Whether it's an elementary report card or a secondary grading shift, the change from initiative to best practice does not happen overnight.

Chapter 3: Development of a Standards-Based Classroom

I have been teaching science for 15 years. Upon taking a job in Solon five years ago, I learned they had begun the process of moving toward standards-based grading. The district however, did not have a systematic plan for helping new teachers implement standards-based grading. This was not surprising in light of the fact that very few Iowa school districts had begun to explore standards-based grading at that time. The problem of practice investigated in this paper is "How do teachers effectively communicate learning progress and promote continued growth in a high school physics classroom using standards-based grading?" In the next paragraphs, I will describe the development of standards-based grading in my high school physics classroom at Solon grounded in the five major components of standards-based grading previously described in the literature review.

Development of Standards-Based Grading for High School Physics at Solon CSD

Solon schools started their journey with a standards-based grading initiative as a teacher-driven grassroots movement (Townsley, 2013). A small group of teachers studied the literature on standards-based grading and piloted elements of standards-based grading within their classrooms. A two-year implementation followed from 2012/13-2013/14. Since that time, both teachers and administrators have revisited and continue to tweak aspects of the movement. Today, the learning-focused system of standards-based grading has matured from being considered another district initiative into best practice at Solon High School.

Identifying the Big Ideas or Standards...in Physics.

Local, state, or national standards. It all starts with the standards. The first step in developing a standards-based grading system is identifying the big ideas within your content area. In this section, I will describe several attempts I made in identifying standards followed by my current practice. Prior to a common set of state standards, teachers were required to write their own standards. Often times there are local, state, and/or national standards already in place that can be drawn from. Other sources include the internet, teacher networking, or professional organizations such as NSTA. With the adoption of state standards in Iowa, this first step in standards-based grading, identifying standards, has become a bit easier. I was responsible for incorporating SBG into our high school physics classes at Solon. I began this process by having several conversations with area physics teachers. I collaborated with one teacher in particular from a nearby district regarding standards-based grading. We discussed the big ideas referencing National Science Education Standards, Project 2061, the Iowa Core science standards at the time, as well as textbook scope and sequence, and read science education gurus from the internet. We also discussed the options of using standards that were based on content, skills, behavior or even some combination. This decision of whether or not to tease apart content, skills, and behavior needed to be made early in the implementation process of standards-based grading. I will address this separation of educational goals in more detail later in this paper under Separating Academic Proficiency from Work Habits/Behaviors.

One virtual mentor in the standards identification process was Kelly O'Shea. Kelly is an educational innovator and a SBG expert. She has a popular blog on all things education and is a speaker at Science/STEM conferences. Drawing on her pedagogic reflections and use of a modeling curriculum, I chose a structure of eight major ideas (standards) that would make up the scope of my physics class. 1) Scientific Thinking, 2) Constant Velocity, 3) Acceleration, 4) Balanced Forces, 5) Unbalanced Forces, 6) Projectile Motion, 7) Energy, and 8) Momentum. However, simply adding titles like

Balanced Forces or Energy as unit headings did little to improve student or parent awareness regarding the knowledge and skills needed to be proficient at understanding physical phenomena. So, next I began reducing these core course topics into specific sets of knowledge and skills a learner should know and do. Solon teachers call this next level of description learning targets and these are the goals directly assessed within my physics gradebook.

Figure 1: Learning Target Sample.

LT--BF 4.1 Drawing Qualitatively Accurate Force Diagrams: identifying all forces acting on an object & showing each with correct labels, directions & sizes. Based on the resulting kinematic model I can predict the type of motion (@ rest, constant or changing velocity). Assessment Questions #1,2,3,4, &15

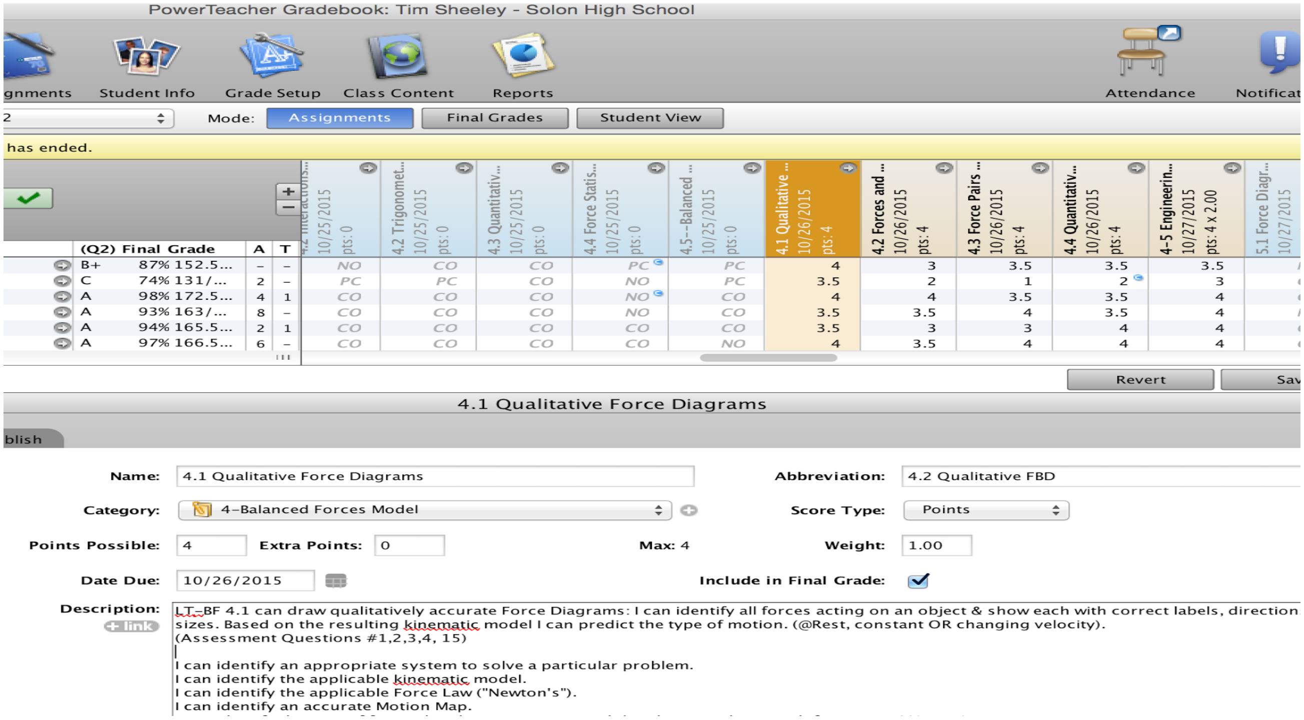
Each learning target was further broken down into "I can…" statements so students can easily chunk and comprehend the expectations for each learning target and ultimately each standard. This student-friendly language also allowed parents, especially those not as familiar with physics, better access to what was being taught/learned inside my classroom. Below are sample "I can" statements translated from the physics learning target "Drawing Qualitatively Accurate Force Diagrams" both of these levels are tiered under the standard "Balanced Forces".

Figure 2: I Can... Statement Sample.

I can identify an appropriate System to solve a particular problem. I can identify the applicable Kinematic Model, either constant velocity or acceleration. I can identify the applicable Force Law (Newton's 1st, 2nd, or 3rd) I can identify an accurate Motion Map using vectors. I can identify the type of force, the object receiving, and the object applying each force.

Communicating with stakeholders. Once standards had been established, the next step was communicating these big ideas to stakeholders. In this case the stakeholders were students and their parents. Most school districts have a digital gradebook through which student-learning levels are shared with the students themselves and their parents. Solon uses an electronic gradebook by PowerSchool, but there are many more programs available on the market and several are developing their capabilities to fit more seamlessly with SBG. Using the district-provided PowerSchool gradebook, I recorded both graded learning targets and non-graded practice (homework) side by side in the gradebook. I further described the targets with the "I can…" statements in a note section available for each assessed item. Students and parents could then access reports of learning progress at any time or place. Figure 3 below is an example of a sample grade report available to students and their parents. In Figure 3 the standard shown is Balanced Forces, the next level describes underlying learning targets. This level is the assessed and graded tier. The learning target shown is the first in unit four..."qualitative force diagrams" and includes a general description in the box. Going deeper, I listed out six "I Can.." statements for students to utilize as a specific checklist for their learning. They should review this list as they progress through the learning and reflect if they know and can do these targets.

Figure 3: Gradebook Sample.



Communication through SBG has helped students figure out what they did and did not know when an assessment was given. For example, in Figure 3 above, the second student has a recorded level of 2 out of 4 for the learning target "Quantitative Force Diagrams". This is the fourth learning target under the Balanced Forces standard and is described this way--I can draw quantitatively accurate Force Diagrams using Newton's first law. It is further broken down to state: I can write summation equations for forces in an axis plane. (Fx or Fy...) I can apply trigonometry to determine a resultant (or component) force vector. I can apply the Pythagorean theorem to determine a force. This student knows that a gap in his understanding can be found specifically in one of these three areas and he can review the assessment problems listed next to the description (#14a-e, 16, 17b-c) along with direct feedback from me on his test for more details on improving his level of learning. This is very different from a traditional gradebook recording that would have shown this test score without description regarding which content was and was not mastered.

This change in student thinking about and usage of the gradebook did not happen overnight. I had to help students interpret the electronic gradebook. They were used to seeing tests and homework scores in PowerSchool. Now, they see major assessments broken down into standards and these big ideas are what they should be looking for in the gradebook. Rather than seeing tests, quizzes or homework that needs to be completed or revised, students see their current level of learning regarding drawing quantitative force diagrams or, in broad, balanced forces. At a building level, students are required to look at their online gradebook during Monday homeroom time in order to identify standards they still need to learn for the upcoming week.

Students have become better able to identify areas they needed to work on, as a result of identified standards. The following example helps to illustrate this point and occurred during my second year of implementation. One of my students missed three of four questions regarding a particular standard. These were the only questions he missed on a 30-question (multi-standard) assessment. Ironically, the student expressed frustration to me that if I wasn't using standards-based grading he would have received an "A" on the assessment (implying that he would need to do nothing more). However, since he failed the standard on Newton's Third Law, according to the feedback I provided to him on the assessment and through the gradebook, more work would need to be done. SBG not only helped this young man identify an area that needed improvement, but also encouraged perseverance and helped plug a gap in his understanding that, according to his words, would have gone unfilled without this system in place.

Communication through SBG has not only helped students figure out what they did and did not know, but also helps parents understand strengths and areas that need improvement. One example of parents being better able to see and understand what was being taught and how their students were doing because of posted standards took place through email. Before standards-based grading a concerned parent might contact me and inquire how their student could earn more points to raise his or her grade on the next homework assignment or the next test. This type of contact was typically very narrow in scope as the parent was looking for a better grade for his/her child, not necessarily increased learning. In contrast, during my second year of implementation a similar parent contact began with the parent acknowledging a low mark in a particular academic area and asking what practice I had available that could help their student better understand the concept of momentum. The difference between gaming the system for points and utilizing a system to pinpoint gaps to be filled was clear to me and to the parent.

It should be noted, that there may be more concepts taught and learned within the boundaries of a course than merely the standards posted. For example, at different points in the curriculum some students might be ready for enrichment challenges, while others may require specific and repeated experiences with the same topics, but these identified standards are the essential learnings needed to be scientifically literate. I have both stretched students to plan and build a hovercraft for unique experience while guiding others to online simulations at phet.colorado.edu that can be repeated multiple times to help assimilate novel learning for a newbie to physics. Ultimately structuring my class with identified standards and communicating these via a course gradebook provided a more accurate representation of student proficiency in physics and communicated a sharper image of the actual learning goals within my physics class to parents.

Establishing a proficiency scale. Once standards have been established and communicated, how to score standards is an early implementation step that should be considered carefully. Prior to standards-based grading, I assigned a point value to each question on a quiz or test. In standards-based grading, a total point value is not entered into the gradebook. Instead, each standard and the student's current level of learning of that standard are entered into the gradebook. Different levels of learning can be described and communicated with a proficiency scale. A description such as "gets it" or "needs work" must be connected to each numeric level for the purpose of communicating student learning through the gradebook. At Solon, a consistent scale was not originally set and the multitude of variations that teachers chose confused parents. The possibilities of grading scales ranged from 100-point to 2-point, in addition to a few more complex versions. The more numbers and descriptors a teacher includes in a scale, the more subjective it becomes. The extreme example of this subjectivity is to compare the task of discerning student work as either at a 93 or 92 point-level of proficiency using a 100-point scale, which is arguably impossible. This is compared to the other extreme example of simply judging either proficiency or non-proficiency on a scale of 1 to 0. In the first, case the high number of gradations causes a high amount of uncertainty in precision and definite subjectivity. The second case, binary scale, is void of embedded detailed feedback and would not be viable in any system that requires letter grades be assigned. In the next paragraphs, I will describe the iterations I used in developing a proficiency scale to communicate student learning through the gradebook. I aimed for practicality as a teacher, yet usefulness for students and clarity for parents.

At the beginning of my SBG journey, I opted for a 10-point proficiency scale. This seemed to have an advantage in that points converted easily to familiar percentages

(90,80,70) and thus was an easier sell to students and parents new to standards-based grading. The drawback to this familiarity was that students and parents did not want to stray from this when more preferred, options were later considered. Another advantage of this scale was the inclusion of a 9 equaling an A grade. Few A-students pursued reassessment and this positively diverted teacher time from a focus on kids who were already strongly proficient and unnecessarily striving for perfection to a focus on students with less than proficient understandings at a 5 or 6 mastery of the material. I set this 5 as the lowest score possible, unless I received absolutely no evidence of learning at all. My rationale for this was that a "5/10" showed low understanding in clear need of improvement, but did not negatively affect a student's grade the way that a 0 would. Zeros have a significant impact on student grades, sometimes enough to prevent passing a class.

SBG can support many proficiency scale alternatives, yet the number of variations was eye-opening. Taking the time to reflect on the simple benefits of a smaller numeric scale, including limiting subjectivity led me to readily accept the scale eventually proposed by the district as required for all teachers. The Solon district-wide scale is shown below. This scale was established by a group of Solon teachers for the entire building to adopt.

Figure 4: Proficiency Scale

4	3.5	3	2	1	0
Demonstrates thorough understanding (of course or grade level standard)	Demonstrates understanding (of course or grade level standard)	Demonstrates a developing understanding (of course or grade level standard)	Demonstrates partial understanding (of course or grade level standard)	Demonstrates minimal understanding (of course or grade level standard)	*No evidence of understanding submitted so far.

*Or "0" is included in gradebook following an absence time in which an assessment has not yet been submitted.

Building practical rubrics. Now that a consistent scale had been established for the purpose of communicating learning progress of the big ideas in all district subjects through the gradebook, each physics standard was paired with a content-specific rubric that described the expectations for learning at a particular level. Listing the major points included in a "thorough understanding" of acceleration in my classroom through a rubric helped me to better teach, assess and communicate my physics standards. Initially, I labored over creating detailed rubrics with precise language in hopes of removing any subjectivity and making my physical scoring process easier. As you see in Figure 5 below, the vector nature of motion and use of +/- symbols is repeated within the rubric. This was purposeful in establishing it as critical for understanding accelerated motion. In particular, this helped me to teach the concepts of frame of reference and relativity. It helped students to see various types of acceleration; speeding up, slowing down, and changing directions.

Figure 5: More Detailed Content-Specific Rubric.

UNIT# 3--Constant Acceleration Particle Model (CAPM)		
CAPM.1 I can differentiate between velocity, change in velocity, and acceleration.		
I can demonstrate that vectors have both magnitude and direction, (Velocity = ^x/^t NE & Acceleration = ^V/^t SW)		
I can describe motion reletive to a frame of reference. (+/-)		
MASTERY	**4**	NO MISTAKES PRESENT. A PRECISE and CLEAR understanding is demonstrated throughout ALL work and attention to detail is clearly indicated.
PROFICIENT	**3**	MINOR MISTAKES PRESENT IN ANY OF THE FOLLOWING AREAS: referring to ^velocity as acceleration or vice versa, not using signs (+/-) to indicate vector quantities.
DEVELOPING	**2**	MAJOR MISTAKES PRESENT IN ANY OF THE FOLLOWING AREAS: using velocity and acceleration interchangeably.
LOW / NO EVIDENCE	**1**	INCOMPLETE - NO EVIDENCE PRESENT; PROBLEMS NOT ATTEMPTED
CAPM.2 I can draw and interpret diagrams (x-t, v-t, motion maps *AND A-T GRAPHS*) to represent the motion of an object moving with a CHANGING VELOCITY; and... transfer understanding from one model to another.		
I can graph x-t, v-t AND A-T (complete with data points, best fit line, title, variable labels, scaled axes & cross-hatched areas)		
I can draw accurate motion maps, (vectors arrows are quantitative and reach 1/2 way to next dot; motion flow is shown from near the axis to far, velocity solid dot above & acceleration circles below)		
I can provide accurate quantitative descriptions, 1)starting point [relative to the origin], 2)direction of travel [+/-], 3)velocity [constant/not & relative to other objects or self]) 4)acceleration statement		
MASTERED	**4**	NO MISTAKES PRESENT. Graph is complete with axis labeled with variable and units, axis scaled completely, correct title given, data points plotted correctly, a best fit or a line showing object's changing motion.
PROFICIENT	**3**	MINOR MISTAKES PRESENT IN ANY OF THE FOLLOWING AREAS: title (wrong variables used), axes variables and/or units (wrong variables/abbreviations), plotting points (1-2 missed points), or best fit line (missing).
DEVELOPING	**2**	MAJOR MISTAKES PRESENT IN ANY OF THE FOLLOWING AREAS: IV and DV are on the wrong axes, scaling on either axes is not accurate/missing.
LOW / NO EVIDENCE	**1**	INCOMPLETE - NO EVIDENCE PRESENT; PROBLEM NOT ATTEMPTED
CAPM.3 I can describe object motion using diagrams available. (ie. Speeding up or slowing down [++/--/+-/-+])		
I can interpret motion map combinations of (+/-) V and (+/-) A as either speeding up or slowing down?		
I can describe how graph slope represents an object is speeding up or slowing down.		
MASTERED	**4**	NO MISTAKES PRESENT. A PRECISE and CLEAR understanding is demonstrated throughout ALL work shown / specific descriptions of motion in regards to both velocity and acceleration frames of reference.
PROFICIENT	**3**	MINOR MISTAKES PRESENT IN ANY OF THE FOLLOWING AREAS: referring to slowing down as deceleration, reversal of frame of reference.
DEVELOPING	**2**	MAJOR MISTAKES PRESENT IN ANY OF THE FOLLOWING AREAS: lack of connection between v-t & a-t graphs or v & a frames of reference.
LOW / NO EVIDENCE	**1**	INCOMPLETE - NO EVIDENCE PRESENT; PROBLEM NOT ATTEMPTED

Once I put the rubric into practice, I realized exceptions to each of the preset levels I had so carefully created. Typically, I found student errors that I had not accounted for in my rubric. For example, according to the rubric in Figure 4, if a student did not use the signs of +/-, then they demonstrated a specific proficiency of "3" on the first learning target; differentiating velocity, changing velocity, and acceleration. Yet, if a student omits signs in all problems or repeatedly comes to incorrect numeric answers because of missing signs in their work, then a score of "2" is a better representation of the this student's learning. Also, consider the student who mistakenly interchanges velocity and acceleration. The rubric dictates this performance as a 2. Yet, this student had shown proficiency in all formative work prior to the assessment. In my opinion, a score of "3" is a more appropriate and accurate reflection of their learning. Talking with other teachers, I learned that many of them ran into similar problems in creating rubrics for their courses. After some iterations, I realized that no rubric could account for all possible student conceptions. Because of unique experiences and abilities, each student has a slightly different mental model of the same content. This led me to implement more flexible and useful rubrics. A generalized version seen below in Figure 6, sans the rigidly prescriptive levels, required more professional judgment, in the evaluation of student work, but coupled with specific teacher feedback on assessments I found it to be more practical for the teacher and more beneficial for the student. In comparison, the newer rubric in Figure 6 still breaks learning targets down into I can statements, but does not prescribe inflexible constraints to each. I applied this to a student who had incorrect answers for three of five total learning targets under the unbalanced forces standard rubric seen below. This included applying ratios like coefficient of friction, using proportional reasoning, and solving Newton's second law problems. After her individual reflections, assessment corrections and conferencing with me, we determined her gaps were not in all these areas, rather in one area that affected many. This standard-linked feedback and flexible rubric allowed me to provide quality guidance and an accurate evaluation to help focus her on only what needed to be corrected in her personal preconceptions of net force.

Figure 6: Less Detailed Content-Specific Rubric.

UNIT# 5--Unbalanced Forces Particle Model (UBFPM)

MASTERED	4	NO MISTAKES PRESENT.
PROFICIENT	3	1-2 MINOR MISTAKES PRESENT
DEVELOPING	2	1-2 MAJOR MISTAKES PRESENT
LOW / NO EVIDENCE	1	INCOMPLETE - NO EVIDENCE PRESENT; PROBLEM NOT ATTEMPTED

UBFPM.1 A I can use multiple diagrams/graphs (x-t, v-t, a-t, MM, FBD) to represent objects moving at a (constant or...) changing velocity.
I can transfer accurate understanding from kinematics to forces using multiple representations (diagram/graph/motion map).

UBFPM.2 A I can draw quantitatively accurate FBDs: all forces shown w/ correct labels, directions, signs & sizes.
I can identify which kinematic model is appropriate & therefore, predict the type of motion. (constant= CV, @R, OR changing= CA)
I can identify an appropriate system to solve a particular problem. (PM, MM, NL, SYS, FBDon/by)
I can identify the type of force, the object receiving, and the object applying the force. F?(On/By)

UBFPM.3 B I can solve quantitative problems using Newton's 2nd Law.
I can find both individual and net forces.
I can use proportional reasoning and F=ma to solve for force, mass, or acceleration.

UBFPM.4 I can use proportional reasoning to understand forces and motions.
I can identify the relationships between net Force, system Mass and Acceleration.

UBFPM.5 B I can apply ratios (ie. coefficient of friction and pressure) to problems.
I can apply the Coefficient of Friction to find forces and motions (accelerations).
I can connect Force and Area to solve for pressure.

MASTERED	4	NO MISTAKES PRESENT.
PROFICIENT	3	1-2 MINOR MISTAKES PRESENT
DEVELOPING	2	1-2 MAJOR MISTAKES PRESENT
LOW / NO EVIDENCE	1	INCOMPLETE - NO EVIDENCE PRESENT; PROBLEM NOT ATTEMPTED

Without professional judgement, no rubric is able to fully anticipate student misconceptions. The idea that less is more allowed me more time re-teaching problematic standards and less time evaluating student work. Because my rubrics remained fluid, I now provide better feedback to students and assess their work more consistently and fairly.

Separating Academic Proficiency from Work Habits/Behaviors...in Physics.

After establishing standards and communicating them to stakeholders with consistent proficiency scales and rubrics, I next needed to clearly divide what I had determined to be the core standards from everything else. This component of SB grading did not require significant change to my practice. As can be seen in Figure 7 below, prior to a standards-based system my gradebook had three major categories tests, quizzes, and homework on occasion I awarded extra credit. You will see points for work completion, as well as both formative and summative assessments. The latter is a problem because it blends the students' understanding before instruction and feedback with their understanding after multiple opportunities to construct new learnings.

Figure 7: Traditional Gradebook

Chapter 3 Test 02/20/2009 pts: 44	Computation W.. 02/20/2009 pts: 24	Computation Q.. 02/23/2009 pts: 24	Chapter 4 HW 03/05/2009 pts: 27	Chapter 4 Test 03/05/2009 pts: 40	Chapter 5 HW 03/11/2009 pts: 12	Chapter 5 Test 03/11/2009 pts: 24	Portfolio Check2 03/12/2009 pts: 10	Quiz 6.1-5 03/26/2009 pts: 16
43	24	20	31	40	12	22	10	13.5
42.5	24	18	29	40	12	24	10	15
33	9	17	16	30	11	18	8	10
35	24	15	26	30	12	18	10	12.5
35	4	7	14	33	3	24	5	11
44	22	19	31	36	12	21	10	12.5
35	17	19	28	38	12	23	9	15
44	24	23	32	41	12	22	10	15.5
43	24	23	31	35	12	22	8	14.5
33	15	16	31	38	12	23	10	15
43	18	24	31	36	12	23	10	14
43	23	21	32	40	12	24	6	14.5
36.5	15	13	28	40	12	22	8	13

In contrast, my current gradebook explicitly separates stages of learning. The only adjustments I needed to make here were removing homework from the content gradebook and eliminating any form of extra credit.

I strongly believe three things about practice: it is a prerequisite for learning; it depicts effort rather than ability; and it is formative in nature. In order to remove homework from academic grades, I first recorded only homework effort, not performance, as a separate non-graded category. This still communicated faith in the value of practice for building both persistence and cognition without influencing academic standing. Rather than a 1-4 content proficiency score, homework effort was given an alpha-notation representing one of three levels; C=complete; P=partially complete; and N=little/no work done. Later the district established a four-level notation system for homework reporting as the following; CO=complete, MC=mostly complete, PC=partly complete, and NO=not observed. Students for the most part did not balk at this change. Because physics is an upper-level course, most students felt confident they could show mastery through assessments alone and some were even relieved to not be held responsible via a grade to what they believed to be unnecessary busy work.

As for extra credit, it simply no longer exists in my system. I stopped offering extra credit when I began using standards-based grading. Student response to this shift was insignificant. I feel students connected the idea that if credit would not be given for expected daily work then credit for extra activities would not be given either.

Through separating product and process (content and skills), the gradebook more clearly identified educational goals and more accurately communicated levels of proficiency than the traditional grading system in which practice, effort and performance on assessments were combined.

Homework/Practice Does Not Count Towards the Final Grade...in Physics.

Separating identified proficiency standards from non-academic work habits is a non-negotiable aspect of SBG. In the next two sections I will focus on two precise habit/behavior-areas that stakeholders commonly misunderstand and misapply. The first behavior is homework. Some conclude that because homework isn't graded in standards-based systems, it isn't important. Homework is pivotal for learning in any system. Parents and students need to know that in standards-based grading, homework is still corrected for accuracy, still used to provide feedback to learners, and still very much expected to be done. It simply is not incorporated into an academic grade that is supposed to represent student understandings rather than a combination of student learning and student behaviors.

No matter how deeply I understood and agreed that counting homework scores and assessment scores together artificially influenced overall course grades, I couldn't get past my concern that if homework wasn't a part of the grade students would not do it. I had heard the claim that the same students who don't do homework in a traditional classroom where it counts in their grade also won't complete homework in a standards-based classroom, but the students who do the work in traditional classrooms will also do the work in standards-based rooms. My personal experience unfortunately, has been that more students avoid homework when it is not graded. In my classroom this plays out when students make errors on an assessment that they would have made on homework problems if they had done the practice. At that point they might have also made the correction in their understanding and then shown proficiency on this now failed standard. Before having another chance to demonstrate understanding, students are required to do additional practice and conference with me. It has taken me some time to get beyond the frustration of the extra work required by the teacher as a result of student irresponsibility. I now try to limit this happening by working hard to help students see the value of daily practice. Homework is useful at all times in a SB classroom because learning doesn't stop with an assessment. Regardless of outcome, each student is always allowed another chance(s) to work hard and learn more. Through a commitment to homework students can develop persistence and proficiency, in their regular practice of physics.

Still corrected, but not collected. In my standards-based grading physics classroom, I no longer collect homework and enter scores for homework into a gradebook. This was a time consuming practice. Instead, I now start class by sweeping the room, quickly checking for levels of completion as I do still report this student behavior separate from academic standards in my gradebook and then check for accuracy with the whole class. I limit the student workload and do not assign busy work as my assignments are now leaner and more purposeful with direct connections to the assessed standards. On a typical assignment, I give a few answers before it is attempted to encourage effort; other answers are posted for reference; and select problems are reserved for class-wide debate. In these group sessions, students use whiteboards to construct a variety of models representing problem solutions and practice defending their claims to others. I found this homework correction strategy helpful for all students, including those who sadly choose not to do work at home. By connecting with others in class, they too learn and over time, I see increased ownership of learning. Time spent guiding these conversations and encouraging students to dig deeper and peer-correct providing each other with worthy feedback is much more valuable to student learning than collecting papers and entering scores as they are able to adjust and move forward in their learning

Still improved with feedback. Even though homework is not graded in this system, it is evaluated, discussed, and/or debated to provide quality feedback to students in areas where they either struggle or are uncertain. I have found that my teacher feedback has become much more focused with standards-based grading. Since assignments are more purposeful, feedback on homework/practice is targeted, directly tied to assessed-standards. Students can also reference each standard's rubric and see specifically which "I can…" statement needs work. They can then adjust going forward.

In the past I would check a problem right or wrong and add a brief canned comment or two. I am not sure how this was helpful with learning. Now, when I provide teacher-feedback, I look for clear evidence of select standards in a given piece of homework. To gain a broader perspective than I can give alone, I have students exchange papers and share peer-feedback on certain problems or concepts. I adapted one such strategy from Kelly O'Shea called whiteboard speed-dating. Multiple small groups of students are assigned a problem and given 1-2 minutes to solve it. When a buzzer sounds, groups rotate to the next problem station and make any adjustments or additions to the work done so far with their color of marker. This continues until all groups make a full rotation and we resolve each problem with a full-class discussion. My progression of feedback culminates with self-reflection on occasion. The ultimate goal of education is to teach students to teach themselves and foster lifelong learning. When students think about their thinking they are truly becoming independent learners. In my classroom students might find the following reflection prompts following an assignment or assessment. How did you do on this assignment/assessment? What did you do to prepare? Which standard(s) does it relate to? What do you need to do next? Quality feedback is another essential aspect of practice and student achievement. Standards-based systems focus feedback during the homework/practice phase rather than allow daily work to be a point-chasing venture.

Still expected to be done. Students must interact with ideas through homework/practice to build mental models and accurate understandings. We all learn novel concepts through our mistakes. If homework is not attempted, no mistakes will be made and no learning will take place. Because of this belief, I expect homework to be done. If it is not completed, I may require students to attend study sessions to complete the work. This policy is balanced with a firm knowledge that not all students need to do all the work. Even though the habit of consistent practice is beneficial for any achievement; the level of homework intensity and time-commitment necessary may vary among students. I have begun the process of developing tiers of homework problems to accommodate different student needs. These problems have direct connections to the standards, with the more difficult problems combining more learning targets. The easier problems isolate single targets and build proficiency through a progression. I try to have a couple of challenge problems, standard level problems and progression problems with answers to complete. Students can then self-sort by trying the most difficult problem first and select another level to attempt if desired. I have used this in my classroom when students analyze accelerating objects. Three phenomena tiers for this analysis include an object on an incline, an object with an angled applied force(s) on a level surface, and finally an object on a flat surface with only forces parallel or perpendicular to that surface. Once more, these problems move from most to least challenging in order that students can self-determine what extend they need to practice.

Students must wrestle with ideas in order to make sense of them. Homework is the place where learners struggle with new ideas and where teachers can help with targeted, quality feedback. Each failure moves students one step closer to building accurate models and mastery of these concepts. Homework is no longer just for chasing points, now it is a pathway for chasing gaps in understanding.

One notable challenge regarding homework with standards-based grading is the argument that students won't do homework unless it is graded. I contend that for the reasons described above there is significant value for doing homework beyond recorded points. The grit required to develop proper habits, the delayed gratification involved with only being rewarded following assessments, and the development of learning independence far outweigh the bump one might gain from counting homework in course grades. I continue to remind both students and parents that a mental shift is needed from thinking in terms of pursuing points to thinking in terms of pursuing learning, particularly as it relates to homework completion.

No Extra Credit…in Physics.

Extra credit can take many forms. Extra credit is value/points given to students for doing extra projects, bringing extra supplies, attending extra events, none of which are a requirement for the class. Extra academic credit is often given for non-academic efforts. In the realm of SBG no extra credit should ever be part of an academic grade as it dilutes the meaning of the grade. Also, adding material to some students scores but not others is inconsistent and unfair because the final grade no longer represents the same material for all students.

Before I implemented SBG, I gave extra credit for papers that did not require the same cognitive intensity as the assessments existing within the scope of my regular coursework. Additionally, I struggled to resolve providing opportunities for extra credit when the regular credit was not being mastered. Nor was extra credit appropriate for those already highly proficient because of the grade dilution noted earlier. Now, with SBG my students are allowed extra time, extra feedback and extra practice in order to earn the regular credit. As explained earlier, students are provided with multiple opportunities to demonstrate understanding. In my classroom, students are not allowed to raise their grade without showing proficiency on the core concepts predetermined to be the most important for their future. They must focus on the listed standards.

Besides being disconnected from course standards, extra credit may actually discriminate against those who have a lack of extra funds and are not able to bring in class supplies for credit. Proposed legislation in Iowa would make it illegal for teachers to give extra credit for delivering classroom supplies (Ryan, M. 2017). For these reasons, the whole idea of extra credit was eliminated from my SBG classroom. It was important that this was clearly communicated with my students from the start.

Multiple Opportunities to Demonstrate Learning…in Physics.

After core standards and accompanying scales are communicated, behaviors separated from academic content, and extra credit eliminated, then a process for providing multiple chances for students to show proficiency must be put into action. I have never heard an educator argue that all students learn at exactly the same time and in exactly the same way. Teachers know that learning has a unique timeline and pathway for each student. Demonstration of learning proficiency should be fluid as well to accommodate this reality. Traditional grading systems discourage continued learning by locking in a single time and method for students to demonstrate course understandings. Standards-based classrooms keep hope and learning alive by allowing retakes and redos on assessments. In the next paragraphs, I will describe what the reassessment process looks like in my physics class.

There are many ways to organize a class reassessment process for students. One end of the spectrum is to have a tight framework with high structure, the other is to be open-ended. When I taught freshmen and sophomores, a rigid process was beneficial. Whereas with my physics classes, comprised of upperclassmen, I employ a loose and more low-structured framework, while maintaining certain required steps before students can reassess. In the next two paragraphs, I will describe both high and low structure setups for reassessment in more detail.

The high structure set up would include a limited two-week window from the time the original assessment was returned. Students have one week to initiate teacher contact and sign-up for a time to create a reassessment plan together. One additional week is allowed to complete all steps set in that plan. Required actions include a course notebook being organized, current and complete. This notebook then would be used to make corrections to the flawed assessment. Following corrections a conference with the teacher explaining mistakes and how their thinking has changed would be required. If deemed necessary, additional practice and another conference could take place before releasing the student to allow a reassessment. Reassessments would consist of a similar problem in both make-up and delivery.

In contrast to the tight process above, a low structure set up, which I employ with Physics, has a time window open until the last 3 weeks of the semester. This is purposeful as new course learnings cycle back to earlier learnings and with repeated exposures students make those early connections at different points in the process. Times for reteaching and planning are more flexible. Each week office hours are as listed: Monday--students get feedback on reassessments from the prior week; Tuesday/Wednesday--students can come without appointment to review and/or create a plan for reassessment; Thursday--students conference with the teacher to display clear gains in understanding; Friday--students reassess. Even with the loose system, students cannot just retake an assessment without confronting their errors and figuring out where the misconceptions lie. There is no point in retaking without first showing how student understanding has changed since the first attempt.

In my physics class, most students did not wait until the deadline to reassess as they were influenced by learning-while the context was fresh or before a higher cognitive level was needed, as well as school eligibility requirements and parent expectations. Still there existed a number of students trying to improve overall grades who reassessed in the last week they were allowed.

Implementing a SBG system, like implementing any initiative, can be done a multitude of ways. The best advice is to start small, with just one of the major components described above and one content area, then expand from there. Implementation should also be kept fluid. As you learn more you can adjust your grading system to better fit district strengths and limitations, as well as unique demographics.

Getting Stakeholders on Board at Solon

My role as a physics teacher was to implement the standards-based grading guidelines as previously described in this chapter. An important part of this district shift to SBG was getting stakeholders on board during our building's transition. In this section, I will briefly describe how administration, parents, and students came together during this shift.

The most important group of this shift was administration. Without their support and vision, none of this could have happened in Solon. Early on, a small group of teachers started to implement standards-based grading in their classrooms. By the end of the 2010-11 school year, administration noted a growing number of high school teachers beginning to use standards-based grading, therefore it made sense to spend the 2011-12 school year considering a system-wide shift. Studying SBG for a year allowed for professional development time, discussions at our school improvement advisory committee (SIAC) and at the school board meetings. The early adopting teachers played an important role during this study year as well, because their experiences, pro and con, were often shared as examples during professional development, SIAC and board meetings.

Because educational reform fads often come and go, many teachers, both experienced and new, balk at change. Solon administration continued a strong role in helping teachers approach the SBG initiative with an open attitude by establishing a reasonable implementation timeline of 2 years. Additionally, a Tight/Loose Framework was created in which some aspects of SBG were non-negotiable and others allowed for different interpretations. Professional development and resources provided background knowledge. Collaboration time was set aside to share concerns and to express disagreements with and enthusiasm for the new system. All of these efforts were to allow teachers assimilation time to wrap our heads around how SBG would look at Solon and what to prepare for. From the outset of implementation, a majority of teachers jumped headfirst into SBG. Even skeptical teachers felt the progressive push and were willing to give it try. Ironically, this strong staff response caused some growing pains, as we worked through inconsistencies between teachers and buildings that often accompany a fast start to any initiative.

Parents in the Solon school district are heavily invested in the success of their children; therefore it was important to involve them in the process as we made adjustments. As a district, we did not do the best job informing them at first. Following scores of emails to staff and concerned citizen-speakers at board of education meetings, the administration responded by setting up several Q&A meetings. They sent informational emails to families, attended PTO meetings and organized the current SBG research into a reference page with videos describing our new guidelines/protocols on the district website.

Students too needed to be brought on board. Beyond all of the SBG resources assembled on the district website accessible 24/7, teachers formed a special schedule on the first day of classes that has continued each year since. Students rotate through a variety of stations regarding school issues including the SBG themes of reassessment and homework. We try to connect these academic aspects to success in and out of the classroom and beyond their days at Solon High School. The discourse continues with individual classroom discussions, postings of teacher reassessment policies and available office hours along with periodic communications home. With these additional contacts from school to home we saw continued decrease in parental and student concerns as time passed.

As can be seen, it took support, assistance, and buy-in from multiple groups for Solon High School to become one of the first high schools in the state of Iowa to successfully implement standards-based grading. Six years later, our work continues. Beginning this fall, we will have a district SBG implementation guide for new teachers to help ensure our grading guidelines are implemented with fidelity and consistency across the district. We have also developed a parent "how to" guide with annotated screenshots designed to help parents better understand a standards based gradebook.

Chapter 4: Reflections on Implementing SBG

What I Learned from Implementing a Standards-Based Grading System in Physics.

The problem of practice investigated in this paper is "How do teachers effectively communicate learning progress and promote continued growth in a high school physics classroom using standards-based grading?" In the previous chapters, this problem of practice was investigated through examining the history of grades, the evolution of standards-based grading, the characteristics of this approach, and finally my implementation of the key components of SBG in a physics classroom. Next, this paper transitions to my personal reflection: the things I learned and plan to improve upon in the future related to the SBG problem of practice.

Creating a focus. Through the process of determining content standards, I have learned to prioritize certain ideas over others. Ever-increasing amounts of information available make it difficult to discern which concepts are most worthy to be the key standards featured in my SBG classroom. Yet, doing the work of establishing specific learning goals with attainable progressions has helped me better focus each day of classroom instruction. The breakdown of standards into Learning Targets and further into "I can…" statements, makes student achievement more focused and manageable by providing a purposeful instructional and learning pathway. This chunking structured around learning goals and "I can" statements also guides my teacher feedback through micro steps toward the bigger picture of physics phenomena while troubleshooting with students. SBG has also taught me the importance and logic of explicitly connecting my standards to instruction, practice, and assessments. These three components of curriculum all need to be clearly aligned for maximum results. In summary, standards-based grading has created a tighter focus for me as an instructor, and for the students in my physics classroom.

Adding meaning. The second lesson I have learned is that standards-based grading has added meaning to my grades. When blending behaviors and academics students have a range of ways in which they can earn an A that goes far beyond the intent of simply showing proficiency on course content. Grades diluted by tasks, like homework or extra credit, have little value in communicating accurate information about what a learner understands to students, their parents, or future contacts. Realizing this lack of meaning included in my own traditional grades was convicting, as I had reported hundreds of marks throughout my career. Looking forward, my standards-based grades now have clear meaning for all. Students can track their learning and fill in gaps; parents can observe areas of strength or needed improvement; teachers can differentiate instruction with enrichment or reteaching; and post-secondary personnel can be confident regarding the reported levels of academic proficiency achieved. Separating behavior from content is required to clearly communicate and properly motivate academic achievement of students. In summary, standards-based grading has added practical meaning to my grades; useful for student learning, parent communication, and teacher instruction.

Building a culture of growth and empowerment. The third lesson I learned is that standards-based grading has helped me build a philosophy of growth and a culture of empowerment in my physics classroom. I now understand and believe that high achievement in physics is available to all students through SBG. Since all standards are reassessable, and individual timelines for mastery accepted, learning never has to stop. Each mistake, including on assessments, simply moves students one step closer to success. This growth mindset encourages persistence by allowing students to continue learning and relearning at their own pace as long as it takes to achieve proficiency. Because students can see their own areas in need of improvement, they are empowered to initiate reassessment, practice, gain feedback and succeed more. Standards-based grading has made me more confident that kids leaving my classroom today possess knowledge and skills needed to be proficient in the next levels of physics. In conclusion, SBG allows students to assume clear ownership and direct their personal learning progress without limits on the degree of success they can achieve which can continue beyond my classroom.

Next Steps in Developing a Standards-Based Classroom.

In the previous section of this chapter, I described some of the things I learned as a result of implementing SBG in my physics classroom. Learning within SBG, as well as about SBG never stops. In the next paragraphs, I will communicate next steps in further developing standards-based grading in my physics classroom.

Considering new standards. A first step in further developing SBG in my physics classroom is considering new standards. With the recent adoption of the Next Generation Science Standards our department has spent professional development time both in district and at our AEA learning how to align and implement these new national standards into each of our curriculums. My initial scope of content covered kinematics, mechanics, energy, and momentum. Since NGSS have come out, I am working on unpacking and bundling the performance expectations portion that the state of Iowa has adopted as our state science standards. These include the additional areas of waves, electricity and magnetism. Challenges I see include finding the time to expose students to all standards listed, and to prioritize the most important of these in which to focus deeper learning.

Assessing behaviors. Another area of development of SBG at Solon includes reporting student behaviors in addition to academic standards though they would remain disconnected from each other in the gradebook. Following several teachers' attendance at a Tom Guskey standards-based grading workshop last March, information was shared about a work habits report card addendum idea. The middle school tried out this approach for the first time during the 4th quarter last year. Along this same line high school teachers will soon be piloting an evaluation report of select 21st century skills for each student. Our district has spent the most time in the past several years improving our gradebook and very little time on our report card. We have also spent more time focusing on "product" criteria (content standards) and not much time talking about "process" (behavior/work habits) criteria. Three important process criteria were identified under the category of employability skills and are planned to be piloted at Solon in the near future work completion, respect, and engagement. Challenges involve creating an appropriate employability rubric in order to evaluate these skills.

Online tools. The last planned development to our SBG system encompasses a move to a new online grading system next year. PowerTeacher Pro (PTP) has the ability to record authentic assessments for individual students to show standard proficiencies in a way potentially unique from their classmates. Additional differentiation options in PTP include going beyond some standards with enrichment and reinforcing others with interventions. All of these are able to be communicated but without diluting the course grade using this new grading platform. Teachers can also see the full learning progress of any student at one time and better target reteaching. Grasping the new system with an all new interface and new codes for recording homework will be a challenge for the entire staff.

Challenges Remaining to be Addressed.

In the previous paragraphs, I described the things I will be working on to improve standards-based grading in my physics classroom. There are still gaps that have yet to be filled. In the next section, I will articulate a few of the challenges that remain to be addressed.

Reassessment limitations. One challenge I face as I add more of the engineering practices into course requirements is the cost in time and materials for reassessing projects. The district permits certain assessments to be exempt from reassessing for either logistic (excessive time or material needs) or summative purposes. My catapult project is an example of problem-based learning that requires a good amount of time and material to complete. I am looking at alternatives for reassessment of this project. Evaluating a simulation or other canned data is one possibility, though not ideal. Final tests in high school classes are an example of a non-reassessable summative assessment. The fast turn around required to have scores recorded for transcripts makes reassessment impractical if not impossible. Limited summative assessments without retakes may be reasonable, even a benefit to students preparing for the next level of coursework where assessments are often all summative. Continuing the conversation with colleges and graduates will help in this area.

Homework engagement. Regardless of personal philosophy regarding homeworks' inclusion in grades, most teachers recognize the value of practice. Believing strongly in practice, I am pursuing options to increase student investment in this habit. Adding any grade incentive for homework completion; however small, compromises the overall beliefs put forward in this paper and is not an option. Alternatively requiring practice work to be completed (or certain percentage accurate) before a student is allowed to take the assessment is a real option. However, ongoing research of the literature and schools that successfully motivate homework engagement is needed.

Practices as standards (and content as the context). Another challenge that goes back to the first steps of SBG implementation is determining what standards are deemed essential. As reported above, when Iowa accepted NGSS, they only required the performance expectations be addressed, not the disciplinary core ideas, science and engineering practices or cross cutting concepts. Practically teachers then need to choose standards that relate directly to these performance expectations and this is what I had done. Now, some teachers have expressed interest in exploring the science and engineering practices as course standards. Most sources promote content over skills and behaviors as the preferred dimension for standards. This is likely because content is most traditional to teach; familiar to view by stakeholders; and more certain to assess at varying age levels.

Attempting to expose my students to the benefits of the NGSS Practices while maintaining a content standards-based system, I have added mini-design challenges where students investigate, build models, attempt multiple solutions and analyze the resulting data. The content is graded while science and engineering practices are merely embedded but not graded. I continue to seek ways of efficiently assessing skills and communicating the evaluation separate from content.

Though the core of my SBG physics classroom is established, challenges remain and work still needs to be done to progress toward best practice for all student learning.

Connections to UNI Science Education Core Courses.

Trends in science education reform. One significant idea learned from my *Trends and Issues in Science Education* core course is that education reform in America historically oscillates between process and product. The newest reform in science education has been the Next Generation Science Standards (NGSS) which replaced the Framework for K–12 Science Education in 2012. This framework had replaced the National Science Education Standards (by the National Research Council) and the Benchmarks for Science Literacy (by the AAAS) - both formed in the early-mid 1990s when standards-based education reform began.

As the standards evolved, content and skills were adjusted or added. Waves, electricity, and magnetism are new subject areas embedded within the physics standards. The original process skills also changed, morphing into the Science and Engineering Practices outlined in NGSS. Within each of these iterations there was a separation of skills and content.

While developing a SBG system at Solon, I applied a distinction of process and product by separating skills from content. Initially, following district guidelines, I installed science content as my identified standards. However, the reform pendulum appears to be swinging back toward processes and encouraging the application of different skills sets. I described earlier my embedding of design challenges into my physics class where students are exposed to both content and skills in the form of science and engineering practices.

Separately, Solon is discussing a dual-purpose report card this fall that communicates both academic performance and work habit success. I will be piloting Employability Standards from the 21st Century Skills from the Iowa Core Curriculum this fall. Although these work habits are not the same as the NGSS Engineering Practices mentioned above, both are skills and will be separated from the content in my classroom gradebook. These micro-trends of process or product focus in my classroom represent larger education trends nationally.

Developing science curriculum. One significant idea from my UNI *Developing Science Curriculum* core course emerged from state level reform covered as part of that course. The "Characteristics of Effective Instruction" document was included in the Iowa Core Curriculum and one of its tenets was Assessment FOR Learning (Formative Assessment). I applied understanding of formative assessment to my standards-based system by removing any learning in progress (homework) from the overall course grade. The connection is that homework is an in-process activity and should not be included in a grade representing summative, assessment OF learning. Another tenet of the Characteristics of Effective Instruction that I applied to my SBG system is Teaching for Learner Differences. This point recognizes the uniqueness of each student. SBG connects to this principle by having an open timetable for learning to take place and rewarding full credit whenever mastery is shown regardless if during the first or fifth week.

Future Directions for Professional Growth.

In addition to the things I learned, improvements to be made, challenges that lie ahead, and connections to my coursework, I have ideas in mind for growing as a professional related to this problem of practice. The first is grouping questions on assessments by standard rather than mixing them. I have considered this change in the past as it cleanly organizes ideas both for the student and teacher. The problem I see is that real life is not this compartmentalized and there is real value in being able to recognize which model to use on a particular problem rather than being told ahead of time. The next area of growth is to continue tiering my homework assignments in a way that better recognizes consistent areas of student struggle and that creates better problems targeting preconceptions. The next area of growth is learning about growth mindset. I share with my own children that smart is not something that you just are--it is something you do; built over time and effort. I want them and my physics students to embrace this research-supported philosophy, but I need more depth of knowledge to promote and embed this in my classroom.

This creative component has allowed me to grow professionally and learn much about grading, communication, feedback, and assessment. From this, I will be able to more clearly and more accurately teach physics and report learning to students, parents, and other stakeholders.

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Appendix

Solon Standards-Based Grading Resources
http://www.solon.k12.ia.us/vnews/display.v/SEC/District%7CAcademics%3E%3EStandards-Based%20Grading/Reporting